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SUGARBEET RESEARCH

1963 REPORT

Compiled by Sugarbeet Investigations

**CROPS RESEARCH DIVISION
AGRICULTURAL RESEARCH SERVICE
UNITED STATES DEPARTMENT OF AGRICULTURE**

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Agricultural Research Service
Crops Research Division
Beltsville, Maryland

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^{1/} This is a progress report of cooperative investigations, containing data, the interpretation of which may be modified with additional experimentation. Therefore, publication, display, or distribution of any data or statements herein should not be made without prior written approval of the Crops Research Division, ARS, U.S. Department of Agriculture, and the Cooperating Agency or Agencies concerned.

FOREWORD

SUGARBEET RESEARCH is an annual compilation of research accomplishments by staff members of Sugarbeet Investigations and by Cooperators.

The Report is a medium for presenting results of investigations that have been strengthened by contributions from the Beet Sugar Development Foundation and for reporting research accomplishments under Cooperative Agreements between the Crops Research Division of Agricultural Research Service, U.S. Department of Agriculture, and the Beet Sugar Development Foundation, the Farmers & Manufacturers Beet Sugar Association, and Union Sugar Division, Consolidated Foods Corporation.

Research at Salinas, California, on virus yellows has been strengthened through contributions from the California Beet Growers Association, Ltd.

Some of the investigations reported by staff members of Sugarbeet Investigations, as well as the field tests reported by Cooperators, have not been supported by the Beet Sugar Development Foundation or other cooperating agencies; therefore, Foundation project numbers or credit statements on "Part" title pages should not be construed as an indication that all investigations received support from the agency mentioned.

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AN ERA OF EXPANSION

Dewey Stewart

Recent events related to our beet sugar industry indicate that the Sugar Act Amendment of 1962 marks a significant epoch in the history of the sugarbeet in the United States. The domestic sugar industry has experienced market support and stability of production under the various revisions of the Sugar Act of 1937, and the consumer has been provided with sugar at bargain prices. However, in recent years the restrictive provisions of the Sugar Act have discouraged expansion by both the processor and the grower.

The recent crisis in the world's sugar supply prompted the U.S. Department of Agriculture to lift acreage restriction on sugarbeet production for 1963, 1964, and 1965. Governmental encouragement of increased domestic sugar production, together with a favorable sugar market, has brought about a remarkable expansion in production. For the 9-year period 1955-1963, sugarbeet production increased 89.7 percent. The 1963 sugarbeet crop alone showed 27 percent increase over the 1962 crop.

The progressive increases in sugarbeet production between 1955 and 1962 were processed in spite of the decreasing number of active factories and no new factory construction. The daily processing capacities were increased for many factories and the campaigns were lengthened. It is worthy of note that in many districts the operating period of the processor is now approximately equal to the growing season of the producer.

Expansion under Law.--The Sugar Act Amendment of 1962 provides for growth and expansion of the beet sugar industry attuned to the annual increases in sugar requirement that are related to growth in population. The Amendment stipulates that the Secretary of Agriculture shall reserve each year, from the national sugarbeet acreage requirement, an acreage required to yield 65,000 tons of sugar and shall commit the acreage to new growers supplying new factories in a new area. It is contemplated that this would enable the establishment of one new factory each year with two new factories in each third year.

In the distribution of sugarbeet acreage reserves, the determinations and selections shall be based upon several criteria such as suitability of the area for growing sugarbeets, the desire to grow the crop, the need for a new crop, proximity to markets, and the firmness of capital commitments for factory construction.

Feasibility of Expansion.--The suitability of the sugarbeet to new districts becomes the keystone of the entire expansion program that will require approximately \$20 million for each new factory and a large outlay of capital by the growers for equipment. Therefore, a wealth of information based on experimental tests and commercial field trials is a prime requirement of each request for acreage allotment from the national reserve.

Public Hearings.--Hearings were held September 25-28, 1962, for the presentation of testimony to support requests for acreage allotments for 20 facilities: 1 in 1963, 5 in 1964, and 14 in 1965. Based on the testimony presented at the Hearings, acreage allotments for 1963 were awarded to a factory under construction at Mendota, California; for 1964, to factories near Hereford, Texas, and Phoenix, Arizona; and for 1965, to a factory near Drayton, North Dakota, and one in southeastern South Dakota.

Hearings were held December 10-13, 1963, for the presentation of testimony for the remaining acreage reserve through 1966. Two requests were presented for 1965 quotas and 21 requests for 1966 quotas. These presentations were from Washington to Maine and south through Virginia, Tennessee, Texas, and Arizona, and represent a new level of public interest in sugarbeet production across the United States.

The acreage allocations to Arizona and South Dakota were revoked October 19, 1963, because substantial progress in construction was not demonstrated. It is significant that one reason for delay in factory construction in South Dakota was the need to further appraise the disease hazards in the region.

New Factories.--In August 1963, the Mendota factory of Spreckels Sugar Company began operation. The Holly Sugar Corporation factory at Hereford, Texas, is scheduled to operate in 1964; and the American Crystal Sugar Company factory at Drayton, North Dakota, is under construction and will begin operation in 1965. These three factories are the first new ones in the United States since 1954.

On January 10, 1964, an acreage allotment was granted to the Finger Lakes Sugar Beet Growers Association and the Pepsi-Cola Company for a factory to be constructed in the vicinity of Auburn, N. Y. The factory is scheduled to operate in 1965. It is of interest that sugarbeets from the commercial trials in New York were shipped to Michigan for processing and that the sugar was returned to New York State. Thus, for the first time in more than 20 years, homegrown sugar was available in that State.

The 1966 acreage reserve awards, which will permit construction of two new factories, have not been announced. Requests for acreage were presented at the Hearings by 21 localities. Several of these presented substantial evidence of ability and desire to grow sugarbeets. Since the Hearings, 7 localities have submitted additional capital arrangements to the Department of Agriculture for factory construction.

Sugarbeet Investigations cooperated with State Agricultural Experiment Stations and Agricultural Extension Services, as well as with grower groups in several States, in the conductance of variety trials and feasibility studies. In addition, beet sugar companies conducted extensive exploratory commercial trials in several new districts.

The Sugar Act Amendment of 1962 has given the greatest boost to growth and expansion of the beet sugar industry and sugarbeet production since the first successful factory was put into operation at Alvarado, California, in 1870. The new era of growth and expansion should intensify sugarbeet culture in present districts of production and encourage productions in new geographical regions, thereby presenting new challenges to research and technology.

Programs of research should be strengthened and accelerated to supply guidance and support to growth and expansion. In the past, the potential of research has been commensurate with the needs of the sugarbeet, and equal success should be achieved in meeting the challenges of the future.

RESEARCH ACCOMPLISHMENTS

A. Variety Evaluation and Seed Production

Monogerm Seed Production.--Sugarbeet seed productions for 1955 through 1963 (P. 21) were taken from AGRICULTURAL STATISTICS. Preliminary statistics show that the 1963 sugarbeet seed crop was 86.7 percent monogerm. The seed crop of 1962 was 88.5 percent monogerm. In most districts, suitable monogerm hybrids have superseded multigerm varieties; but in a few districts, the changeover has not been complete. The development of monogerm varieties of sugarbeets suitable for the American grower has been a noteworthy accomplishment in which all agencies of sugarbeet research--such as government, industry, and seed-producing enterprises--have made significant contributions.

Productive Monogerm Hybrids.--New monogerm 3-way hybrids based on a male-sterile F_1 (562 X 569) as seed-bearing parent have been produced as a result of the breeding research of J. S. McFarlane and associates and will be made available to growers in California in 1964. The pollinator will characterize the commercial hybrid and determine regional adaptation. These monogerm hybrids will supersede the present multigerm varieties. Fall plantings of sugarbeet variety trials by K. D. Beatty in the Imperial Valley have supplied advance information on performances of new developments in breeding research.

The regional field trials conducted in the Great Lakes region in cooperation with Farmers & Manufacturers Beet Sugar Association clearly demonstrated progressive improvement of new hybrids over SL 122ms X SP 5460-0 previously used in the region (p. 123). Significantly, improvement in commercial hybrids is brought about by use of a pollinator (SP 5822-0) that has excellent quality. The variety trials conducted by G. J. Hogaboam (USDA), M. R. Berrett (F&M), and cooperators clearly indicate that the best hybrids are statistically superior to the multigerm variety SP 5822-0 in roots and sugar.

Multigerm Varieties.--The multigerm varieties SP 5822-0 and SP 6051-0, developed largely in the breeding research conducted by G. E. Coe, have shown characteristics worthy of note. SP 5822-0 has shown leaf spot resistance, and precise and meaningful chemical tests have indicated high technical quality. Thus with the same quantity of gross sugar per ton of roots, the high quality of SP 5822-0 would give higher sugar recovery than varieties of lower quality. It has also been shown that when SP 5822-0 is used as pollinator its excellent quality characteristic is imparted to its hybrid progeny.

SP 6051-0 carries resistance to both leaf spot and curly top. In cooperative regional tests at Artesia, New Mexico, where both curly top and leaf spot occurred in epidemic proportions, the root yield of SP 6051-0 was more than double that of SP 5822-0, which is resistant to leaf spot but susceptible to curly top (pp. 205-208). In tests conducted under leaf spot exposure at Beltsville, the two varieties showed approximately equal resistance to the disease (p. 209). The leaf spot resistance of SP 6051-0 was developed in breeding work at the Plant Industry Station, Beltsville, Md., and the curly top selections were made by J. C. Overpeck in cooperation with New Mexico Agricultural Experiment Station. (See Sugar Beet Research, 1961 Report, pp. 2, 81, and 341.)

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B. Breeding and Genetics

Monogerm Male-Sterile Parents.--Cytoplasmic and Mendelian factors of the sugarbeet comprise the generative device utilized in the production of commercial hybrid seed. The key to the device is the type-0 line and its male-sterile equivalent. The monogerm male-sterile lines 562 and 569 developed by J. S. McFarlane are promising additions to such parental material. The results of 1963 indicate that the male-sterile F_1 , 562 X 569, will have wide use with complementary pollinators in the production of 3-way hybrids for use in California. Monogerm type-0 line C 3550 is a valuable addition to the breeding material at Salinas.

Ten type-0 monogerm lines have been developed in the breeding research of J. O. Gaskill (p. 181). The male-sterile equivalent of these lines has demonstrated excellent combining ability in experimental hybrids. Field trials with experimental hybrids in which the new type-0 lines were used as female parent clearly indicated that the diversity of use of these lines would depend upon the diversity of character of the available pollinators.

Polyploidy.--The results of V. F. Savitsky have shown that the triploid hybrid is highest in combining ability, the tetraploid second highest, and the diploid lowest. Significantly, in his breeding material many tetraploid populations or hybrids did not exhibit the usual tetraploid depression in yield. Some tetraploid monogerm hybrids outyielded the diploid monogerm hybrids and exceeded the triploid hybrids in percentage sucrose.

The triploid hybrids produced with tetraploid 663 as pollinator (Hammond, p. 63), produced higher tonnage of roots than did the corresponding diploid hybrids in field tests conducted by J. S. McFarlane, but the triploid hybrids were inferior in sucrose percentage. The triploid hybrids showed significantly higher bolting resistance than did the corresponding diploids but they were more susceptible to curly top. The diploid and triploid forms in the test at Davis, California, were similar in yellows resistance.

Interspecific Hybridizations.--The cytological investigations of Helen Savitsky have presented explanations of the irregular meiotic configurations that occur in hybrids obtained by crossing cultivars of the sugarbeet (Beta vulgaris) with species in the section Patellares. The cytological principles being established will permit more direct approach to the genetic transfer of characters of the wild species to the sugarbeet.

Principles and Procedures.--Studies by LeRoy Powers and R. J. Hecker on the comparative effects of levels of total nitrogen, potassium, and sodium in the petioles and thin juice on weight per root, percentage sucrose, and apparent purity in sugarbeets have shown that the associations between levels of total nitrogen in the thin juice, percentage sucrose, and percentage apparent purity are negative; furthermore, for the latter the association is so close ($r = -0.95$) as to practically preclude the possibility of genetically combining high total nitrogen in the thin juice with high percentage apparent purity.

Studies on chemical genetics, by Powers and Hecker, further indicate that the higher levels of total nitrogen, potassium, and sodium in the petioles are conducive, if not essential, to the production of high root yields. The studies indicate that there is no reason why the metabolic requirements of higher yields of roots, percentage sucrose, and percentage apparent purity cannot be met by producing and growing genotypes which at the time of harvest have higher levels of total nitrogen, potassium, sodium, and phosphorus in the petioles rather than in the thin juice.

Populations of sugarbeets were found to differ in the relative levels of total nitrogen, potassium, and sodium in the petioles as compared with levels of these same chemicals in the thin juice. Some genotypes have higher levels of these three chemical characters in the petioles associated with lower levels in the thin juice. This finding is of importance and shows that populations can be bred that will have the high levels of these chemicals in the foliage (petioles) rather than in the roots (thin juice).

Nematode Resistance.--The persistent efforts by Helen Savitsky to bring about the genetic transfer of the extreme nematode tolerance of Beta patellaris to cultivars of the sugarbeet have been followed with interest. The results reported by H. Savitsky and Charles Price are most rewarding (p. 297). It is gratifying that large hybrid populations are now available for evaluation. Some hybrid plants with sugarbeet characteristics have remained free of attack by Heterodera schachtii when grown under precise and positive exposure to the pathogen. In a large backcross progeny, 33 plants had few nematodes developing to maturity in their roots. These highly resistant plants are currently receiving thermal induction, and seed production is anticipated.

In the breeding work by Charles Price, progress is being made toward the development of inbred lines and breeder seed of sugarbeets that have a high level of tolerance to Heterodera schachtii. In field tests conducted under severe exposure to the nematode, several new breeding lines were significantly higher than US 41 and US 75 in root yield. Further studies tend to point to soil fungi as accessory pathogens to the damage generally attributable to the cyst nematode. In a crock test, soil infestation by fungi caused a reduction of 12.7 percent in root weight; and by the nematode, 26.7 percent. Both categories of pathogens caused damage of 45.8 percent when combined as inoculum. Further research is needed to separate this disease complex into its component parts, thereby permitting a more logical approach to development of control measures.

Autotetraploid Lines.--The work of Helen Savitsky (p. 291), B. L. Hammond (p. 63), and G. E. Coe (p. 375) has resulted in significant additions of 4n lines available for evaluation. Inbred lines and breeder seed submitted to a contractor in Spain have supplemented the supply of autotetraploid lines at all Stations.

Autotetraploid lines are of primary interest in production of triploid hybrids, but some breeders have found improvement of economic characters such as disease resistance (V. F. Savitsky, p. 269), and prevention of spider mite damage (Hammond, p. 70).

The Haploid sugarbeet isolated from a mixed ploidy progeny by B. L. Hammond (p. 69) is of genetic interest. If his attempts to produce a diploid progeny from this plant meet with success, it will be the first time a completely homozygous sugarbeet has been produced. The production of autodiploids from haploid plants permits establishment of a perfection of homozygosity in one generation than that attainable in many generations of selfing.

Combining ability tests, conducted by G. J. Hogaboam and M. R. Berrett (p.161) on breeding material developed largely in the breeding work of Hogaboam and Coe, have indicated the breeding value of certain lines as pollinators or as female parents in the production of monogerm hybrids. These tests point to the need of having in the pollinator strongly marked characteristics desired in the resultant hybrid. Additional studies on combining ability tests are reported by Gaskill (p. 180), Ryser and Theurer (p. 92), and McFarlane (p. 26).

C. Disease Investigations

Yellowing of sugarbeet foliage is widespread in this country, but the highest incidence occurs in the Western States. Yellowing is not a specific symptom and may be induced by different causal agents. The research of C. W. Bennett and coworkers has shown progress in separating the disease complex into its components.

Beet Yellows is largely limited to California and the seed-producing areas of Arizona. In these districts the prevalence and damage by the virus are associated with and probably largely dependent on presence of sugarbeets throughout the year. Complete destruction of all sugarbeets in an area, even for a short period in the year, has markedly reduced the incidence of the disease.

Beet Western Yellows probably occurs throughout the Western States and to a lesser extent in the Midwest. The causal virus occurs in a number of weed hosts in which it probably persists in an area in the absence of the sugarbeet. However, if sugarbeet plants are present throughout the year, the infected ones can serve as an effective primary source of the virus and thereby favor widespread infection in new crops of sugarbeets. In 1962, beet western yellows was observed in Utah, Idaho, Washington, and Oregon. The disease is known to occur in Colorado and Montana, and probably in Michigan.

Strains of the viruses have been discovered which differ strikingly in their ability to cause damage in the sugarbeet. It is well established that the beet yellows virus and the beet western yellows virus differ strikingly in ability to cause damage and that within each of the viruses the isolates differ markedly in virulence. Most of the isolates of beet yellows virus have a high degree of virulence, and damage appraisal tests over a period of 12 years show a range of 20 to about 60 percent loss. The maximum damage to commercial varieties ranged from 30 to 40 percent. In a greenhouse test

with a strain of beet yellows from Grimes, California, and beet western virus from Longmont, Colorado, the 14 entries of breeder seed gave a range of no demonstrated damage to as high as 32.7 percent for the beet western yellows (Colorado) and 7 to 52.4 percent for beet yellows (California). When plants of the same entries were infected with both viruses, the damage was approximately equal to the sum of damages found for the viruses when used alone. In field trials it was demonstrated that beet yellows virus and beet western yellows virus induced a reduction in sucrose percentage as well as in root yield.

Curly top isolates, which are as virulent as the well-known potent strain 11, have been found in northern Utah by C. L. Schneider. The virus isolates from sugarbeets and from the leafhopper vector, Circulifer tenellus, were approximately equal in virulence. The tests with these curly top isolates demonstrated that strains capable of causing severe damage to sugarbeet varieties previously designated as highly resistant occur in the desert areas as well as in the sugarbeet districts of Utah.

Cercospora leaf spot on the same breeding material did not show the same relative damage in different locations. D. L. Mumford was unable to conclude whether the difference in reaction is due to difference in strains of the pathogen, effect of environment on the host, or on the pathogen.

Nematology Investigations.--Studies on the cyst nematode, Heterodera schachtii, by A. E. Steele, Nematology Investigations, and associates, M. J. Fife and Charles Price, Sugarbeet Investigations, are given in Part IX of this Report. The studies by Steele and Fife show that the hatching factor for H. schachtii, produced by the sugarbeet root, is not affected by freezing and drying and that the hatching activity is lost only slowly by boiling.

D. Physiology

Seed Investigations.-- Seed germination studies (p. 370) by F. W. Snyder have demonstrated that in commercially harvested seedlots percentage germination appears to be inversely related to the percentage of immature seed, as indicated by dark-colored fruits.

Viability of sugarbeet seed under refrigeration for part of the test in Utah has been demonstrated by C. H. Smith to be for as long as 35 years. Although the germination had reduced from 83.5 to 22.1 percent in 35 years, the surviving seed produced plants of normal growth in the field. These results should be of interest to sugarbeet breeders, since they demonstrate that proper storage may enable the breeder to maintain seed of choice lines for approximately the professional life of a geneticist.

Photosynthesis and respiration rates in attached sugarbeet leaves were greatly influenced by leaf arrangement of the foliage bouquet in the research of Myron Stout. This investigation will have a bearing on the relative efficiency on density of the leaves as well as shading effect among leaves of the sugarbeet plant.

P A R T I

NEW DEVELOPMENTS IN BREEDING RESEARCH

Items Proposed for Seed Increase 1963
and
Utilization and Distribution of Items

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Seed Production of 1962 Items

PRODUCTION OF MONOGERM SEED IN U S.A.

NEW DEVELOPMENTS IN BREEDING RESEARCH

Items Proposed for Seed Increase May 21, 1963

Breeder seed, inbred lines, and hybrid varieties, which have been developed in the breeding research conducted by the staff of Sugarbeet Investigations, are proposed for seed increase through the Beet Sugar Development Foundation. Seed not needed for planting overwintering plots will be furnished on request to company members of the Foundation for utilization in their breeding programs. Brief descriptions, current designations, and estimates of seed available August 1, are given for the items.

These new products of breeding research have been developed by the staff of Sugarbeet Investigations in work conducted under Cooperative Agreements with:

Colorado Agricultural Experiment Station
Michigan Agricultural Experiment Station
Minnesota Agricultural Experiment Station
Utah Agricultural Experiment Station
Beet Sugar Development Foundation
Farmers & Manufacturers Beet Sugar Association
Union Sugar Division, Consolidated Foods Corp.

Items Proposed for Seed Increase and Utilization

I. U.S. Agricultural Research Station, Salinas, California.

A. Developments in breeding research by J. S. McFarlane and associates; B. L. Hammond, and I. O. Skoyen:

Item 1. C3550 Monogerm 2 pounds

A curly-top-resistant and type O selection from S₄ (507 X NB6). This is a sister line of C1546 (Item 12 of 1961) and C2549 (Item 14 of 1962) which were made available in 1961 and 1962.

C3550 is superior to both of these lines in curly top resistance. Bolting resistance and combining ability have not been determined but are expected to be good.

Suggested utilization: (a) Increase C3550 and its male-sterile equivalent; and (b) produce an F₁ hybrid using 563HO as the seed-bearing parent. (See Item 3.)

Item 2. C3550HO Monogerm 2 pounds

A male-sterile monogerm derived from a cross between 546HO and C3550. This is the first back-cross to a segregate of 607 X NB6.

Suggested utilization: Use C3550HO as the seed-bearing parent in the production of the male-sterile equivalent of C3550.

Item 3. C3550H1 Monogerm 5 pounds

An F_1 monogerm hybrid between 563HO and C3550. This F_1 hybrid is expected to have curly top resistance equal to that of the best "US" multigerm hybrids.

Suggested utilization: Use C3550H1 as the seed-bearing parent in the production of 3-way hybrids.

Item 4. C3505 Monogerm 1 pound

The second backcross of a monogerm inbred to NB1. Performance tests have not been made, but the line should possess characteristics similar to NB1.

Suggested utilization: Probably of greatest value as a breeding line. Can be increased, if desired.

Item 5. C330 Multigerm 1 pound

Fifth successive selection from US 75 for resistance to virus yellows. C330 is currently being tested for yellows resistance and is expected to be damaged only about half as severely as US 75.

Suggested utilization: (a) Increase; and (b) use as pollen parent in producing experimental quantities of hybrid seed.

Item 6. C3425 Tetraploid multigerm 1 pound

Increase of a cross between tetraploids from 663 and NB7. Tetraploids produced by B. L. Hammond. Diploids 663 and NB7 are used extensively as pollen parents in "US" hybrids. 663 is a tonnage type and NB7 tends to be a high sugar parent. C3425 should have good resistance to both bolting and curly top.

Suggested utilization: (a) Increase; and (b) use as pollen parent to produce experimental quantities of hybrid seed.

B. Developments in breeding for nematode resistance, by Charles Price:

Item 7. 033-1 Multigerm 1/2 pound

This multigerm breeder seed originated from 56-408 which was received from R. E. Finkner, American Crystal Sugar Co., for test for nematode resistance. In screening test at Salinas, Calif., 56-408 was about as susceptible to the cyst nematode Heterodera schachtii as US 41 which is used as a check. Through successive greenhouse and field selections, however, a relatively high tolerance to the nematode has been achieved, and under severe nematode exposure in field and greenhouse tests, 033-1 has been significantly superior to US 41. Tests in which 033-1 occurred are reported in Sugarbeet Research, 1962 Report, pp. 258-262.

Suggested utilization: (a) Seed increase; and (b) use 033-1 as a pollinator to produce hybrids.

Item 8. 019 Multigerm 1 pound

This multigerm breeder seed originated from US 400, which is resistant to leaf spot. 019 is very vigorous and in tests under severe exposure to H. schachtii in field and greenhouse has outyielded commercial variety US 41. See Sugarbeet Research, 1962 Report, pp. 258-262. 019 is an easy bolter; and it has not been evaluated for leaf spot resistance.

Suggested utilization: (a) Make seed increase; (b) use as pollen parent in production of hybrids.

Item 9. 060-3 Multigerm 1 pound

This breeder seed was synthesized from US 33 by interpollination of 10 selfed progenies selected in the greenhouse for nematode tolerance. Seed from these plants was planted in greenhouse and field tests, and further selections were made under severe exposure to nematode at Salinas, Calif., and moderate exposure to nematode at Toppenish, Wash. The test at Salinas was reported in Sugarbeet Research, 1962 Report, pp. 258-262. In the test at Toppenish by Utah-Idaho Sugar Co., in 1961, 060-3 yielded 28.4 tons per acre and

Item 9 (cont.)

14.5 percent sucrose. The lowest yield in this test was 11.6 tons per acre by a curly top susceptible line.

Suggested utilization: (a) Increase; (b) use as pollen parent to produce hybrids.

C. Developments in breeding and genetic research by Helen and V. F. Savitsky:

Item 10. S-132 Tetraploid Multigerm 1 pound

Leaf-spot-resistant, self-sterile, multigerm breeder seed selected from tetraploid US 401 for vigor and combining ability in the production of triploid monogerm hybrids. Excellent combining ability of S-132 was demonstrated by Utah-Idaho Sugar Co. in 1962 tests of monogerm triploid hybrids in South Dakota.

Suggested utilization: (a) Increase; (b) use as pollinator with diploid male-sterile monogerm seed-bearing parent in the production of leaf-spot-resistant monogerm triploid hybrids.

Item 11. S-204 Tetraploid Multigerm 1 pound

Tetraploid self-sterile multigerm breeder seed with a good grade of resistance to both curly top and leaf spot. S-204 was derived from hybridization of tetraploid strains which are resistant to curly top or to leaf spot, and propagation from the hybrid for three generations. S-204 ($4n$) is equal to US 401 ($2n$) in leaf spot resistance, according to evaluations made by J. O. Gaskill, Fort Collins, Colo.

Suggested utilization: Increase breeder seed S-204 for use as pollinator with a male-sterile, diploid, monogerm seed-bearing parent to produce triploid hybrids that are resistant to leaf spot and curly top.

Item 12. S-302 Tetraploid monogerm 1/2 pound

A tetraploid, self-fertile monogerm line that is extremely bolting resistant. The bolting resistance of S-302 exceeds that found in the usual so-called nonbolting variety.

Item 12 (cont.)

Suggested utilization: (a) Increase; (b) use in hybrid combinations to determine combining ability.

II. Sugarbeet Investigations, Fort Collins, Colorado.

Developments in breeding research by J. O. Gaskill:

Item 13. FC 502 Monogerm 1 pound

Monogerm, type-0, rr, S₁ inbred line with very good leaf spot resistance and good sucrose percentage; derived from the cross, V. F. Savitsky's No. 715 mm ♀ X US 201 MM. Meager, preliminary evidence of good combining ability has been obtained for FC 502. (See Sugarbeet Research, 1962 Report, pp. 141-144.) Key Strain No. SP 581227s1.

Suggested utilization: (a) Increase FC 502 and its male-sterile equivalent (FC 502-CMS); and (b) make the hybrid, FC 503-CMS X FC 502, for possible use as the seed bearer in production of 3-way hybrids.

Item 14. FC 502-CMS Monogerm 1 pound

Monogerm, rr, male-sterile equivalent of FC 502. Seed resulting from 3rd backcross will be available.

Suggested utilization: (a) Increase, using FC 502 as pollinator; (b) make the hybrid, FC 502-CMS X FC 503, for possible use as seed bearer in the production of 3-way hybrids.

Item 15. FC 503 Monogerm 1 pound

Monogerm, type-0 (±), RK inbred line with fairly good leaf spot resistance and medium sucrose percentage; derived (by selfing) from V. F. Savitsky's No. 716 (mm inbred obtained from the cross LSR MM X SLC 101 mm). Preliminary evidence indicates that FC 503 is good in combining ability.

(cont.)

Item 15 (cont.)

(See Sugarbeet Research, 1962 Report, pp. 141-144.) The monogerm and type-0 characters are not perfect--but nearly so. Key Strain No. SP 571702-0.

Suggested utilization: (a) Increase FC 503 and its male-sterile equivalent, FC 503-CMS; and (b) make the hybrid, FC 502-CMS X FC 503, for possible use as the seed bearer in the production of 3-way hybrids.

Item 16. FC 503-CMS Monogerm 1 pound

Monogerm, male-sterile equivalent of FC 503. Seed resulting from the 3rd or 4th backcross will be available. A very low percentage of plants capable of producing a small amount of pollen is expected in this material.

Suggested utilization: (a) Increase, using FC 503 as pollinator; and (b) make the hybrid, FC 503-CMS X FC 502, for possible use as the seed bearer in the production of 3-way hybrids.

III. Plant Industry Station, Beltsville, Maryland.

Developments in breeding research by G. E. Coe.

Item 17. SP 63194-0 Monogerm 100 pounds

Breeder seed produced from selected plants of SP 60194-01 (see Item 19, page 10, Sugarbeet Research, 1961 Report. as well as pages 85 and 88; also, pages 96, 115, 117, 131, and 137, of 1962 Report). The average root yield of SP 60194-01 in extensive field tests of 1961 was equal to that of SP 5481-0 (US 401) and superior to that of the monogerm hybrid SL 122MS X SP 5460-0. Discriminate selection was applied to a large population of SP 60194-01 (grown under leaf spot exposure at Beltsville) to improve leaf spot resistance and root size. The value of SP 63194-0 over its parent, SP 60194-01, depends upon the effectiveness of the selections.

Item 18. SP 63196-0 Monogerm 1 pound

Breeder seed improved in bolting resistance. Approximately 90 percent of selected parental plants were from SP 60194-01. The value of SP 63196-0 depends upon the improvement in bolting resistance, which has not been determined.

Item 19. SP 63624-0 Monogerm 2 pounds

Selections from SP 61624-0 to improve leaf spot resistance. For the performance of SP 61624-0, see Sugarbeet Research, 1962 Report, pp. 96, 99, 125, 129, 131, and 137. SP 63624-0 should give root yield and quality performances equal to SP 60194-01 or SP 5481-0.

Item 20. SP 6122-0 Multigerm 10 pounds

Selections from SP 5822-0 for improvement in leaf spot resistance. The parental variety, SP 5822-0, is excellent in resistance and quality. The available information (See Sugarbeet Research, 1962 Report, pp. 96, 133, and 137) indicates that SP 6122-0 has excellent thin juice apparent purity which characterizes the parental variety SP 5822-0.

Item 21. SP 6322-0 Multigerm 10 pounds

A selection from SP 6122-0 for improvement in leaf spot resistance. The value of SP 6322-0 over SP 5822-0 or SP 6122-0 is the likelihood of improvement in leaf spot resistance.

Item 22. SP 61151-0 Multigerm 1 pound

A selection from SP 5822-0 for improvement in leaf spot resistance and in purity. Field tests of 1962 (Sugarbeet Research, 1962 Report, pp. 133 and 137) indicate that a high level of leaf spot resistance of SP 5822-0 has been maintained in SP 61151-0 and that thin juice apparent purity improved.

Item 23. SP 6256-0 Multigerm 1 pound

Selections for improvement in resistance to black root and leaf spot, using the polycross method. Preliminary tests indicate that SP 6256-0 is good

(cont.)

Item 15 (cont.)

(See Sugarbeet Research, 1962 Report, pp. 141-144.) The monogerm and type-0 characters are not perfect--but nearly so. Key Strain No. SP 571702-0.

Suggested utilization: (a) Increase FC 503 and its male-sterile equivalent, FC 503-CMS; and (b) make the hybrid, FC 502-CMS X FC 503, for possible use as the seed bearer in the production of 3-way hybrids.

Item 16. FC 503-CMS Monogerm 1 pound

Monogerm, male-sterile equivalent of FC 503. Seed resulting from the 3rd or 4th backcross will be available. A very low percentage of plants capable of producing a small amount of pollen is expected in this material.

Suggested utilization: (a) Increase, using FC 503 as pollinator; and (b) make the hybrid, FC 503-CMS X FC 502, for possible use as the seed bearer in the production of 3-way hybrids.

III. Plant Industry Station, Beltsville, Maryland.

Developments in breeding research by G. E. Coe.

Item 17. SP 63194-0 Monogerm 100 pounds

Breeder seed produced from selected plants of SP 60194-01 (see Item 19, page 10, Sugarbeet Research, 1961 Report. as well as pages 85 and 88; also, pages 96, 115, 117, 131, and 137, of 1962 Report). The average root yield of SP 60194-01 in extensive field tests of 1961 was equal to that of SP 5481-0 (US 401) and superior to that of the monogerm hybrid SL 122MS X SP 5460-0. Discriminate selection was applied to a large population of SP 60194-01 (grown under leaf spot exposure at Beltsville) to improve leaf spot resistance and root size. The value of SP 63194-0 over its parent, SP 60194-01, depends upon the effectiveness of the selections.

MEMORANDUM
OF CALL

TO:

Dr. Coe

☒

YOU WERE CALLED BY—

☐

YOU WERE VISITED BY—

Mr. Stewart

OF (Organization)

☐

PLEASE CALL



PHONE NO.
CODE/EXT.

☐

WILL CALL AGAIN

☐

IS WAITING TO SEE YOU

☐

RETURNED YOUR CALL

☐

WISHES AN APPOINTMENT

MESSAGE

Mrs. Icker found a ^{copy} of letter from Jim Fischer to Dr. Granmont (for his signature) on the official release of USH 20 dated March 21, 1968. (over)

RECEIVED BY

Anne

DATE

3/28/71

TIME

12:45

STANDARD FORM 63

REVISED AUGUST 1967

GSA FPMR (41 CFR) 101-11.6

GPO : 1969-048-16-80341-1 332-389

63-108

Item 23 (cont.)

in root yield, percentage sucrose, and purity.
It was used as pollinator in hybrid seed production
(1962-1963) in the greenhouse at East Lansing, Mich.

Item 24. SP 6323-0 Monogerm 6 pounds

A type "O" inbred line which is good in leaf spot
resistance and moderate in black root resistance.
This line was proposed for seed increase and
utilization in 1962 as Item 11 but was withdrawn
for an additional generation of purification and
selection. (See Item 25 for male-sterile equivalent.)

Item 25. SP 6323-01 Monogerm 26 pounds

Male-sterile equivalent of SP 6323-0. (See Item 24)

This male-sterile equivalent was proposed for
seed increase and utilization in 1962 as Item 12
but was withdrawn for an additional generation
of purification and selection. For type "O", see
SP 6323-0 (Item 24).

BEET SUGAR DEVELOPMENT FOUNDATION

P. O. BOX 536
FORT COLLINS, COLORADO

UTILIZATION OF USDA SEED RELEASES, 1963

ITEM NUMBERS AND SEED NUMBERS ARE IDENTICAL WITH THOSE
LISTED IN THE RELEASE MEMORANDUM DATED MAY 21, 1963
AND A LATER SUPPLEMENT

I. U. S. AGRICULTURAL RESEARCH STATION, SALINAS, CALIFORNIA

A. DEVELOPMENTS IN BREEDING RESEARCH BY J. S. MCFARLANE AND ASSOCIATES, B. L. HAMMOND AND I. O. SKOYEN:

ITEM 1. C3550 MONOGERM

OF THE ESTIMATED QUANTITY OF SEED AVAILABLE, THE FOLLOWING COMPANIES WANT THE AMOUNTS AS INDICATED DISTRIBUTED TO THEM NOW: AMALGAMATED - 50 GRAMS; AMERICAN CRYSTAL - 25 GRAMS; GREAT WESTERN - 10 GRAMS; HOLLY - 50 GRAMS; SPRECKELS - 20 GRAMS; AND UTAH-IDAHO - 50 GRAMS; APPROXIMATELY A 0.25 ACRE INCREASE (ALSO SEE ITEM 3) WILL BE MADE FROM THE BALANCE OF THE SEED BY THE WEST COAST BEET SEED COMPANY FROM WHICH GREAT WESTERN WISHES TO OBTAIN 10 POUNDS, THE REMAINDER OF WHICH WILL BE SHARED EQUALLY BETWEEN AMERICAN CRYSTAL, F & M, HOLLY, SPRECKELS AND UNION.

ITEM 2. C3550H0 MONOGERM

THE UTILIZATION OF THIS ITEM WILL BE IDENTICAL IN ALL RESPECTS WITH ITEM 1 (ALSO SEE ITEM 3).

ITEM 3. C3550H1 MONOGERM

NO FOUNDATION INCREASE WILL BE MADE OF THIS RELEASE. PART OF THE AVAILABLE QUANTITY WILL BE DISTRIBUTED AS FOLLOWS: AMERICAN CRYSTAL - 50 GRAMS; GREAT WESTERN - 30 GRAMS; UTAH-IDAHO - 50 GRAMS; A SIMILAR SHARE WILL BE DISTRIBUTED TO F & M, HOLLY, SPRECKELS AND UNION.

THE BALANCE OF THE AVAILABLE QUANTITY WILL BE UTILIZED FOR A 1-ACRE PLANTING BY THE WEST COAST BEET SEED COMPANY USING ITEM 1, ITEM 2 AND 563H0. FROM THE SEED HARVESTED, DISTRIBUTION WILL BE MADE AS FOLLOWS: AMALGAMATED - 5 LBS; GREAT WESTERN - 25 LBS; UTAH-IDAHO - 10 LBS; WITH AMERICAN CRYSTAL, F & M, HOLLY, SPRECKELS AND UNION SHARING THE BALANCE.

UTILIZATION OF USDA SEED RELEASES, 1963

PAGE 2

ITEM 4. C3505 MONOGERM

NO FOUNDATION INCREASE WILL BE MADE OF THIS ITEM. THE AVAILABLE QUANTITY WILL BE DISTRIBUTED AS FOLLOWS: AMALGAMATED - 25 GRAMS; AMERICAN CRYSTAL - 10 GRAMS; GREAT WESTERN - 20 GRAMS; HOLLY - 50 GRAMS; SPRECKELS - 50 GRAMS; UNION - 50 GRAMS; AND UTAH-IDAHO - 50 GRAMS.

ITEM 5. C330 MULTIGERM

FROM THE AVAILABLE QUANTITY THE FOLLOWING IMMEDIATE DISTRIBUTION WILL BE MADE: AMALGAMATED - 10 GRAMS; AMERICAN CRYSTAL - 10 GRAMS; SPRECKELS - 20 GRAMS; UTAH-IDAHO - 20 GRAMS.

THE BALANCE OF THE SEED WILL BE PLANTED BY THE WEST COAST BEET SEED COMPANY WITH THE INTENTION OF INCREASING THE QUANTITY OF SEED AND IN HYBRID COMBINATION AS A POLLINATOR. FROM THE INCREASE OF C330 THE FOLLOWING DISTRIBUTION WILL BE MADE: AMERICAN CRYSTAL - 3 LB; GREAT WESTERN - 2 LB; WITH HOLLY AND UNION EQUALLY SHARING THE BALANCE. THE INDIVIDUAL CROSSES BETWEEN C330 AND 569H1, 569H3, 546H3, AND 509H1 WILL BE SHARED AS FOLLOWS: GREAT WESTERN - 2 LB; THE BALANCE TO BE DISTRIBUTED EQUALLY BETWEEN HOLLY AND UNION.

ITEM 6. C3425 TETRAPLOID MULTIGERM ^{2/}

FROM THE AVAILABLE QUANTITY OF SEED THE FOLLOWING DISTRIBUTION IS TO BE MADE: AMALGAMATED - 25 GRAMS; AMERICAN CRYSTAL - 25 GRAMS; GREAT WESTERN - 25 GRAMS; HOLLY 50 GRAMS; SPRECKELS - 100 GRAMS; AND UTAH-IDAHO - 25 GRAMS. THE BALANCE, NOT THUS DISTRIBUTED AND NOT UTILIZED AS INDICATED BELOW WILL BE USED BY UNION.

APPROXIMATELY A 0.1 ACRE PLANTING OF C3425 CROSSED WITH 569H1 569H2 AND 546H3 WILL BE MADE BY THE WEST COAST BEET SEED COMPANY. THE INDIVIDUAL CROSSES WILL BE SHARED AS FOLLOWS: AMERICAN CRYSTAL - 10 LB; GREAT WESTERN - 5 LB; HOLLY 15 - LB; UNION - 25 LB; AND UTAH-IDAHO - 2 LB.

B. DEVELOPMENTS IN BREEDING FOR NEMATODE RESISTANCE, BY CHARLES PRICE:

ITEM 7. 033-1 MULTIGERM

NO FOUNDATION INCREASE OF THIS SEED WILL BE MADE. FROM THE AVAILABLE QUANTITY, DISTRIBUTION WILL BE MADE AS FOLLOWS: AMALGAMATED - 10 GRAMS; AMERICAN CRYSTAL - 10 GRAMS, GREAT WESTERN - 10 GRAMS; HOLLY - 25 GRAMS; SPRECKELS - 25 GRAMS; UNION - 20 GRAMS; UTAH-IDAHO 25 GRAMS.

^{2/} THE AVAILABLE QUANTITY IS 3 LB, RATHER THAN THE 1 LB. SHOWN ON THE RELEASE MEMORANDUM.

UTILIZATION OF USDA SEED RELEASES, 1963
PAGE 3

ITEM 8. 019 MULTIGERM

NO FOUNDATION INCREASE OF THIS ITEM WILL BE MADE. FROM THE AVAILABLE QUANTITY THE FOLLOWING DISTRIBUTION WILL BE MADE: AMERICAN CRYSTAL - 20 GRAMS; GREAT WESTERN - 20 GRAMS; HOLLY - 50 GRAMS; SPRECKELS - 50 GRAMS; UNION - 50 GRAMS; AND UTAH-IDAHO - 25 GRAMS.

ITEM 9. 060-3 MULTIGERM

NO FOUNDATION INCREASE OF THIS ITEM WILL BE MADE. FROM THE AVAILABLE QUANTITY THE FOLLOWING DISTRIBUTION WILL BE MADE: AMALGAMATED - 10 GRAMS; AMERICAN CRYSTAL - 20 GRAMS; GREAT WESTERN - 20 GRAMS; HOLLY - 50 GRAMS; SPRECKELS - 50 GRAMS; UNION - 50 GRAMS; AND UTAH-IDAHO 25 GRAMS.

C. DEVELOPMENTS IN BREEDING AND GENETICS RESEARCH BY HELEN AND V. F. SAVITSKY:

ITEM 10. S-132 TETRAPLOID MULTIGERM

NO FOUNDATION INCREASE WILL BE MADE OF THIS ITEM. FROM THE AVAILABLE QUANTITY, 50 GRAMS WILL BE SENT TO EACH OF THE FOLLOWING COMPANIES: AMALGAMATED, AMERICAN CRYSTAL, F & M, GREAT WESTERN, HOLLY, SPRECKELS, UNION AND UTAH-IDAHO.

ITEM 11. S-204 TETRAPLOID MULTIGERM

NO FOUNDATION INCREASE WILL BE MADE OF THIS ITEM. DISTRIBUTION FROM THE AVAILABLE SEED WILL BE THE SAME AS FOR ITEM 10.

ITEM 12. S-302 TETRAPLOID MONOGERM

NO FOUNDATION INCREASE OF THIS RELEASE WILL BE MADE. FROM THE CURRENT AVAILABLE QUANTITY, 25 GRAMS WILL BE DISTRIBUTED TO EACH OF THE FOLLOWING COMPANIES: AMALGAMATED, AMERICAN CRYSTAL, F & M, GREAT WESTERN, HOLLY, SPRECKELS, UNION AND UTAH-IDAHO.

II. SUGARBEET INVESTIGATIONS, FORT COLLINS, COLORADO. DEVELOPMENTS IN BREEDING RESEARCH BY J. O. GASKILL

ITEM 13. FC 502 MONOGERM 3/

FROM THE AVAILABLE QUANTITY 10 GRAMS WILL BE SENT TO EACH OF THE FOLLOWING COMPANIES: AMALGAMATED, AMERICAN CRYSTAL, F & M, GREAT WESTERN, HOLLY, NATIONAL, SPRECKELS, UNION AND UTAH-IDAHO. THE BALANCE WILL BE USED FOR INCREASE BY THE USDA AT BELTSVILLE, MARYLAND.

3/ THE ORIGINAL COMPANY REQUESTS FOR UTILIZATION WERE CHANGED TO PROVIDE SUFFICIENT SEED FOR AN INCREASE.

UTILIZATION OF USDA SEED RELEASES, 1963
PAGE 4

ITEM 14. FC 502-CMS MONOGERM 3/

THIS ITEM IS TO BE UTILIZED IN THE SAME MANNER AS INDICATED FOR
ITEM 13.

ITEM 15. FC 503 MONOGERM 3/

THIS ITEM IS TO BE UTILIZED IN THE SAME MANNER AS INDICATED FOR
ITEM 13.

ITEM 16. FC 503-CMS MONOGERM 3/

THIS ITEM IS TO BE UTILIZED IN THE SAME MANNER AS INDICATED FOR
ITEM 13.

III. PLANT INDUSTRY STATION, BELTSVILLE, MARYLAND. DEVELOPMENTS IN BREEDING
RESEARCH BY G. E. COE

ITEM 17. SP 63194-0 MONOGERM

FROM THE AVAILABLE QUANTITY OF SEED THE AMOUNTS INDICATED WILL
BE SENT TO THE FOLLOWING COMPANIES: AMERICAN CRYSTAL - 5 LB; GREAT
WESTERN - 20 LB; HOLLY - 10 LB; SPRECKELS - 1 LB; AND UTAH-IDAHO - 5 LB.
THE BALANCE (59 LB) WILL BE SENT TO THE WEST COAST BEET SEED COMPANY FOR
UTILIZATION BY THE F & M.

ITEM 18. SP 63196-0 MONOGERM

NO FOUNDATION INCREASE WILL BE MADE OF THIS ITEM. THE AVAILABLE
SEED WILL BE SHARED AMONG THE FOLLOWING COMPANIES: AMERICAN CRYSTAL,
F & M, GREAT WESTERN, HOLLY, SPRECKELS AND UTAH-IDAHO.

ITEM 19. SP 63624-0 MONOGERM

FROM THE AVAILABLE QUANTITY OF SEED THE FOLLOWING DISTRIBUTION
WILL BE MADE: AMERICAN CRYSTAL - 25 GRAMS; SPRECKELS - 25 GRAMS; UTAH-
IDAHO - 25 GRAMS. THE BALANCE WILL BE INCREASED BY THE WEST COAST BEET
SEED COMPANY FOR F & M.

ITEM 20. SP 6122-0 MULTIGERM

FROM THE AVAILABLE QUANTITY DISTRIBUTION WILL BE MADE AS FOLLOWS:
AMERICAN CRYSTAL - 1 LB; HOLLY - 1 LB; UTAH-IDAHO - 1 LB; SPRECKELS - 25
GRAMS WITH THE BALANCE GOING TO F & M. ONLY 5 POUNDS OF THE ESTIMATED 10
POUNDS HAS ACTUALLY BEEN RECOVERED FOR DISTRIBUTION.

3/ THE ORIGINAL COMPANY REQUESTS FOR UTILIZATION WERE CHANGED TO PROVIDE
SUFFICIENT SEED FOR AN INCREASE.

UTILIZATION OF USDA SEED RELEASES, 1963
PAGE 5

ITEM 21. SP 6322-0 MULTIGERM

FROM THE AVAILABLE QUANTITY OF SEED (NET OF 60 LB RATHER THAN 70 LB AS ESTIMATED) THE FOLLOWING DISTRIBUTION IS TO BE MADE: AMERICAN CRYSTAL - 1 LB; GREAT WESTERN - 2 LB; HOLLY - 1 LB; UTAH-IDAHO - 1 LB; AND SPRECKELS - 25 GRAMS. THE BALANCE WILL BE INCREASED BY THE WEST COAST BEET SEED COMPANY PRIMARILY FOR F & M WITH HOLLY, AMERICAN CRYSTAL, GREAT WESTERN AND UTAH-IDAHO SHARING IN A PORTION OF THE INCREASE, THE AMOUNTS AND PROCEDURES TO BE NEGOTIATED.

ITEM 22. SP 61151-0 MULTIGERM

FROM THE AVAILABLE QUANTITY OF SEED THE FOLLOWING DISTRIBUTION WILL BE MADE: AMERICAN CRYSTAL - 25 GRAMS; SPRECKELS - 25 GRAMS; WITH F & M, HOLLY AND UTAH-IDAHO SHARING THE BALANCE.

ITEM 23. SP 6256-0 MULTIGERM

FROM THE AVAILABLE QUANTITY OF SEED THE FOLLOWING DISTRIBUTION WILL BE MADE: AMERICAN CRYSTAL - 25 GRAMS; SPRECKELS - 25 GRAMS; WITH F & M, GREAT WESTERN, HOLLY AND UTAH-IDAHO SHARING THE BALANCE.

ITEM 24. SP 6323-0 MONOGERM

AN INCREASE OF THIS ITEM WILL BE MADE BY THE WEST COAST BEET SEED COMPANY PRIMARILY FOR F & M WITH HOLLY, AMERICAN CRYSTAL, GREAT WESTERN AND UTAH-IDAHO SHARING IN THE INCREASE, THE AMOUNTS AND PROCEDURES TO BE NEGOTIATED.

ITEM 25. SP 6323-01 MONOGERM

THIS ITEM WILL BE UTILIZED IN A MANNER SIMILAR TO ITEM 24.

1963 Productions of 1962 Proposals for Seed Increase
(See 1962 Report, pp. 7-14)

1962 Item	Breeder seed description	1963 Production	
		Pounds	Designation
1	CO2563 Monogerm	136	F63-563
2	CO2563HO Monogerm	280	F63-563HO
3	CO2563H1 Monogerm	0	--
4	S-23 Diploid monogerm	0	--
5	S-71 Diploid monogerm	0	--
6	S-201 Tetraploid multigerm	0	--
7	S-202 Tetraploid multigerm	0	--
8	S-301 Tetraploid monogerm	0	--
9	SL 14500 Monogerm annual	0	--
10	SL 14500HO Monogerm annual	0	--
11	SP 6223-0 Monogerm	Few	SP 6323-0
12	SP 6223-01 Monogerm	Few	SP 6323-01
13	C264 Multigerm	544	F63-64
14	C2549 Monogerm	113	F63-549
15	S-133	9	GW A1453-63L
16	S-203 Tetraploid multigerm	138	--

SUGARBEET SEED PRODUCTION IN UNITED STATES, 1955-1963^{1/}

Year of production	100-pound bags			Percent monogerm
	Total	Multigerm	Monogerm ^{2/}	
1955	114,187	114,152	35	Trace
1956	88,279	84,991	3,431	3.9
1957	94,547	83,812	10,735	11.4
1958	109,832	82,571	27,261	24.8
1959	111,788	83,594	28,194	25.2
1960	124,545	49,869	74,676	60.0
1961	95,541	25,227	70,314	73.6
1962	93,416	10,768	82,648	88.5
1963 ^{3/}	94,396	12,487	81,909	86.8

^{1/} Production records are from Agricultural Statistics, except for 1963.

^{2/} Mostly from hybridizations in which the pollen parent was multigerm.

^{3/} Preliminary statistics. Final values will appear in Agricultural Statistics, 1964.

P A R T II

DEVELOPMENT AND EVALUATION
of
INBRED LINES AND HYBRID VARIETIES OF SUGARBEETS
SUITABLE FOR CALIFORNIA
and
STUDIES ON POLYPLOIDY

Foundation Projects 24 and 29

J. S. McFarlane
B. L. Hammond

I. O. Skoyen
K. D. Beatty

Cooperators conducting tests:

American Crystal Sugar Company
Holly Sugar Corporation
Spreckels Sugar Company
Union Sugar Division
Southwestern Irrigation Field Station

REPORT ON FOUNDATION PROJECTS 24 AND 29

Summary of Accomplishments - 1963

PERFORMANCE OF MONOGERM MALE-STERILE PARENTS--Monogerm male-sterile parents are now available which approach the best multigerm parents in performance. The most promising monogerm male sterile in the 1963 variety tests was MS of 562 x 569. This male sterile was a little inferior to both MS of NB1 x NB3 and MS of NB1 x NB5 in curly-top resistance but was equal or superior to these two multigerm parents in bolting resistance. Combining ability was very good in most tests. Results obtained in 1963 indicate that MS of 562 x 569 will have wide adaptation in California when used in conjunction with pollinators such as 663.

The monogerm male sterile, MS of 515 x 562, failed to perform as well as did MS of 562 x 569 from the standpoint of curly-top resistance, bolting resistance, and combining ability.

The new male steriles, MS of 569 x 563 and MS of 562 x 546, showed good bolting and curly-top resistance but have not been evaluated for combining ability.

PERFORMANCE OF MONOGERM HYBRID VARIETIES--The performance of monogerm hybrids was very good in 1963 but was not quite as outstanding as in 1961 and 1962. This was particularly true of hybrids involving the NB7 pollinator. A summary of the performance of (MS of 515 x 569) x NB7 expressed in percent of the performance of US H6 follows:

<u>Year</u>	<u>No. of tests</u>	<u>Gross sugar</u>	<u>Sucrose percentage</u>
1961	9	104	101
1962	13	108	100
1963	14	99	100

The performance of (562 x 569) x NB7 tended to be inferior to that of a similar hybrid involving the 663 pollinator. In eleven California tests the gross sugar of (562 x 569) x NB7 averaged 97 percent and the sucrose percentage 100 percent of US H6. In the same tests both the gross sugar and sucrose content of (562 x 569) x 663 averaged 102 percent of US H6.

The NB7 hybrids are produced by crossing an F₁ hybrid between two inbreds with a third inbred, whereas the 663 hybrids are produced by crossing an F₁ hybrid with an open-pollinated line. The uniform NB7 hybrids possibly respond more sharply to differences in environment than do the 663 hybrids.

Results in 1962 indicated that the NB7 hybrids are more resistant to yellows than are the 663 hybrids. This suggests that they might perform relatively better than do the 663 hybrids in years of heavy yellows infection. The 1963 season was a light yellows year and may have favored the performance of the 663 hybrids.

Both (562 x 569) x NB7 and (562 x 569) x 663 are being increased commercially. The NB7 hybrid is superior in curly-top resistance but has shown less bolting resistance than the corresponding 663 hybrid in the coastal valleys. Tests by the Holly Sugar Corporation show the NB7 hybrid to be superior in bolting resistance in the Central Valley.

SEED LOTS MADE AVAILABLE THROUGH THE FOUNDATION^{1/} - A monogerm inbred designated C3550 and combining resistance to bolting and curly top was made available in 1963. This type O inbred was selected from an S₄ population of 507mm x NB6. It is a sister line of C1546 and C2549⁴ which were made available in 1961 and 1962, respectively. Greenhouse and field tests show C3550 to possess curly-top resistance similar to that of NB1. C3550 bolted 1.6 percent in a November 1962 planting at Salinas and was as resistant as any of the multigerm inbreds.

A male-sterile monogerm designated C3550HO and derived from a cross between 546HO and C3550 was also made available. This line is being used as the seed-bearing parent to produce the male-sterile equivalent of C3550.

An F₁ monogerm hybrid between 563HO and C3550 was distributed for use as the seed-bearing parent in producing test quantities of three-way hybrid seed. This F₁ is expected to be similar in bolting and curly-top resistance to the multigerm parent MS of NB1 x NB5.

C3505, the second backcross of a monogerm inbred to NB1, was made available through the Foundation. Tests at Salinas and at Thatcher, Utah, show C3505 to be superior to NB1 in bolting resistance but inferior in curly-top resistance.

The fifth successive selection from US 75 for resistance to virus yellows has been designated C330 and has been suggested as a pollen parent to produce test hybrids in combination with monogerm male steriles. This selection remains relatively green when inoculated with yellows. It is also significantly more resistant to damage from yellows than is the original US 75.

A tetraploid multigerm designated C3425 is suggested for use as a pollen parent in combination with diploid male steriles. C3425 is an increase of a cross between tetraploids from 663 and NB7 which were produced by Dr. B. L. Hammond. Diploid 663 and NB7 are used extensively as pollen parents in "US" hybrids.

^{1/} See pages 7-9.

A leaf-spot-resistant monogerm inbred designated C2648 may help fill the need for additional type-0 inbred parents for use in producing leaf-spot-resistant hybrid varieties. C2648 is the increase of a leaf-spot-resistant selection made at Fort Collins from S₃(673-2 x 507mm). 673-2 is a type 0 plant found at Salinas in polycross selections from US 401. C2648 had a leaf-spot rating of 2.5 in a 1963 test at Fort Collins compared with a rating of 5.5 for the synthetic check and 0.5 for US 201.

BOLTING RESISTANCE--Bolting occurred in nearly all lines included in a November 15, 1962, planting at Salinas, and additional information was obtained on resistance under coastal growing conditions. Bolting percentages for a group of multigerm and monogerm parental lines planted at Salinas in November 1961, 1962, and 1963 are summarized below:

<u>Multigerm lines</u>				<u>Monogerm lines</u>			
	<u>1961</u>	<u>1962</u>	<u>1963</u>		<u>1961</u>	<u>1962</u>	<u>1963</u>
NB1	46	79	13	515	48	83	50
NB4	--	9	4	546	--	--	6
NB5	2	10	4	562	10	39	17
NB6	0	6	5	563	--	16	6
NB7	2	40	16	569	19	35	32
NB1 x NB4	3	18	11	515 x 569	23	72	35
NB1 x NB5	5	29	15	562 x 569	--	32	13
NB5 x NB6	2	11	5	562 x 546	--	--	9

Results obtained in 1963 provided additional evidence that the relative bolting resistance of inbreds and hybrids is influenced by seasonal environmental conditions. Bolting-resistance information from the Central Valley was not available when the report was prepared.

CURLY TOP RESISTANCE--Field tests conducted in 1963 at Thatcher, Utah, by A. M. Murphy showed that monogerm inbreds are now available with curly-top resistance equal to that of the best multigerm inbreds. The inbred C3550 showed outstanding resistance and was the best of the monogerm lines made available through the Foundation.

Greenhouse testing was continued in cooperation with Dr. C. W. Bennett. Resistance ratings for varieties and breeding lines were similar in the field and greenhouse. However, greater variation in severity of symptoms occurred within varieties in the greenhouse than in the field. Progeny tests showed that plants with the mildest greenhouse symptoms were not always the most resistant to curly top. Results, thus far, with greenhouse selections for curly-top resistance have been disappointing.

EVALUATION OF TRIPLOID HYBRIDS--Triploid hybrids involving tetraploid 663 produced a higher tonnage of roots than did the corresponding diploid hybrids but were lower in sucrose percentage. A summary of the performance of triploid hybrids expressed in percent of the performance of corresponding diploid hybrids follows:

	<u>Year</u>	<u>No. tests</u>	<u>Gross sugar</u>	<u>Acre yield</u>	<u>Sucrose percentage</u>
US H2 (3n)	1962	9	107	109	99
US H2 (3n)	1963	6	106	108	98
US H6 (3n)	1963	16	103	107	96
263H4 (3n)	1963	11	102	106	96

The triploid hybrids showed significantly higher bolting resistance than did the corresponding diploids but were a little inferior in curly-top resistance. Tests at Davis, California, showed that the yellows resistance of diploid and triploid forms of US H6 and 263H4 was similar.

Seed germination has been a serious problem in triploid seed produced in small isolations by the strip method. The problem may be caused, in part, by poor distribution of the tetraploid pollen which is heavier than diploid pollen. A 1963-64 seed planting has been made in which the 663 tetra pollinator has been mixed with the male-sterile parent at a ratio of 1:10.

PRODUCTION OF AUTOTETRAPLOIDS--Dr. B. L. Hammond produced additional tetraploids of the better bolting-resistant breeding lines. He has now produced tetraploids in seven self-sterile multigerm lines, six self-fertile multigerm lines, and nine self-fertile monogerm lines. He has also produced tetraploids in a male-sterile multigerm line and a male-sterile monogerm line. A detailed description of these lines may be found on pages 63-70.

GERMINATION OF MONOGERM SEED--Several commercial increases of bolting-resistant monogerm seed have germinated poorly. Work by I. O. Skoyen has shown that low germination in many monogerm seed lots is associated with tight seed caps which prevents moisture from reaching the seed. By removing the caps, germination was increased more than fifty percent in some very low germinating lots. A detailed report on this work may be found on pages 71-75.

COOPERATIVE VARIETY TESTS--Results with "US" hybrids included in cooperative company variety tests are again summarized in this report. Included are results of all 1963 tests which were completed on December 31 plus the results of 1962 tests which were not available in time for the 1962 report.

OBSERVATIONAL TEST OF SUGARBEET STRAINS GROWN UNDER LEAF SPOT EXPOSURE, 1963
Leaf Spot Field, Hospital Farm, Ft. Collins, Colorado

(Conducted by J.A. Elder & J.O. Gaskill)

Description	Contributors		Ft. Col.		Entry		Leaf spot		Vigor		No. of plots
	no.		no.		no.		8/13	8/22	8/29	8/13	
Ft.C. sel. of M(McF.) inbred	2646-5C1	Acc.	2539		231		0.7	0.8	1.5	4.0	3
Increase of 1646-5C1	2646-5	Acc.	2540		232		1.5	2.2	3.0	3.0	3
Ft.C. sel. of M(McF.) inbred	2646-17C1	Acc.	2541		233		1.5	2.3	3.0	6.5	2
do	2646-23C1	Acc.	2542		234		2.5	5.5	7.5	4.0	2
CT + LS res. M inbred	2646-32-13C1	Acc.	2543		235		5.5	7.5	8.5	3.5	2
Ft.C. sel. of mm (McF.) inbred	2648-3C2	Acc.	2544		236		1.5	1.8	2.5	6.0	2
do	2648-9C1	Acc.	2545		237		1.8	2.5	4.0	4.5	2
do	2648-11C2	Acc.	2546		238		1.3	1.8	2.5	5.5	2
do	2649-30C1	Acc.	2547		239		1.0	2.0	3.0	5.5	2
Bolt. res. sel. SL 016	267	Acc.	2548		240		1.5	2.8	3.8	6.3	3
NB7	0539	Acc.	2549		241		6.0	7.3	8.3	2.7	3
NB7 (4n)	2539T	Acc.	2550		242		6.8	8.0	9.0	2.0	3
Top cross parent	663	Acc.	2551		243		1.8	4.0	4.7	5.0	3
663 (4n)	F62-63T	Acc.	2552		244		2.8	5.2	5.7	5.3	3
Tetraploid	1413	Acc.	2553		245		3.5	5.0	6.0	6.0	3
US 201 (501007-0)		581001-0			246		0.5	0.5	0.5	7.0	2
SP 5481-0	EL - 1023	Acc.	2483		247		0.9	1.8	2.6	7.8	4
Synthetic Check	WC 0464	Acc.	2269		248		4.0	5.3	5.5	6.0	2
Bolt. res., mm, inbr., v.g. CTR	C 2563	Acc.	2524		249		2.0	4.5	6.5	4.0	2
CMS of C 2563	C2563HO	Acc.	2525		250		2.0	5.3	7.0	4.0	2

a/ Leaf spot (J. A. Elder): 0 = no leaf spot; 10 = complete defoliation.

b/ Foliage vigor (J. A. Elder): Higher no. = greater vigor.

Field Plan: Plots 2 rows x 12'; rows 20" apart. Artificial inoculation and frequent sprinkling were employed to promote the development of leaf spot.

SUMMARY.--Gross sugar yields of bolting-resistant hybrids in 1963
California variety tests, expressed in percent of the yield of US H6.

Location	Testing Agency	US H6	US H2	2539H1 mm	263H4 mm	2539H4 mm	263H6 mm	2539H6 mm	264H1	263TH1	263TH2	263TH1- mm
<u>Coastal Area</u>												
Salinas - Nov. plt.	USDA	100	99	102	105	96	102	97	108	112	113	106
Salinas - Dec. plt.	"	100	94	99	100	99	94	93	103	104	107	103
King City	Union	100	101	98	104	98	99	97	101	109	108	108
San Ardo	"	100	96	94	99	92	93	97	-	-	102	-
Betteravia	"	100	-	94	96	92	94	94	-	-	102	-
Spreckels - Test 1	Spreckels	100	-	103	110	100	107	101	-	-	-	-
Spreckels - Test 2	"	100	98	-	90	-	-	-	-	88	90	106
Spreckels - Test 3	"	100	-	112	-	-	-	-	-	-	95	-
Spreckels - Test 4	"	100	-	104	-	-	-	98	-	-	-	-
Alisal	"	100	-	102	-	-	95	-	-	-	-	-
Greenfield	"	100	101	109	-	-	-	-	-	-	-	-
<u>Central Valley</u>												
Dixon	Am. Crystal	100	-	80	97	89	95	77	-	-	-	-
Crows Landing	Spreckels	100	-	-	-	-	100	96	-	101	105	105
Tulare Lake	"	100	-	-	111	-	107	97	-	105	104	107
Yettum	"	100	-	-	-	-	-	-	-	88	87	-
Visalia	Holly	100	-	-	106	113	-	-	-	-	-	-
North Tracy	"	100	-	93	103	100	-	-	-	-	101	100
<u>Imperial Valley</u>												
Brawley - Early	USDA	100	101	100	94	98	97	87	103	106	104	102
Brawley - Late	"	100	101	100	96	91	-	-	101	110	107	103
Imp. Val. - 1st bar.	Holly	100	-	-	103	-	-	-	-	-	104	96
" - 2nd "	"	100	-	-	99	-	-	-	-	-	105	98
" - 3rd "	"	100	-	-	108	-	-	-	-	-	108	102

Description of multigerm hybrids:

US H6----(MS of NB1 x NB5) x 663
 264H1----(MS of NB1 x NB5) x Bolt. res. sel. fr. 663
 263TH2----(MS of NB1 x NB5) x 663 Tetra
 US H2----(MS of NB1 x NB3) x 663
 263TH1----(MS of NB1 x NB3) x 663 Tetra

Description of monogerm hybrids:

2539H1----(515H0 x 569) x NB7
 263H4----(562H0 x 569) x 663
 2539H4----(562H0 x 569) x NB7
 263H6----(515H0 x 562) x 663
 2539H6----(515H0 x 562) x NB7
 263TH4----(562H0 x 569) x 663 Tetra

SUMMARY.--Sucrose percentage of bolting-resistant hybrids in 1963 California variety tests, expressed in percent of US H6.

Location	Testing Agency	US H6	US H2	2539H1 mm	263H4 mm	2539H4 mm	263H6 mm	2539H6 mm	264H1	263TH1	263TH2	263TH4 mm
<u>Coastal Area</u>												
Salinas - Nov. plt.	USDA	100	101	99	109	104	105	97	102	101	100	98
Salinas - Dec. plt.	"	100	101	101	103	101	101	97	106	101	101	100
King City	Union	100	100	101	100	99	103	99	101	99	98	103
San Ardo	"	100	99	100	100	98	101	99	-	-	98	-
Betteravia	"	100	-	98	99	97	100	97	-	-	99	-
Spreckels - Test 1	Spreckels	100	-	102	105	102	102	98	-	-	-	-
Spreckels - Test 2	"	100	101	-	104	-	-	-	-	95	95	102
Spreckels - Test 3	"	100	-	98	-	-	-	-	-	-	94	-
Spreckels - Test 4	"	100	-	98	-	-	-	96	-	-	-	-
Alisal	"	100	-	97	-	-	103	-	-	-	-	-
Greenfield	"	100	100	99	-	-	-	-	-	-	-	-
<u>Central Valley</u>												
Dixon	Am. Crystal	100	-	96	101	95	100	94	-	-	-	-
Crows Landing	Spreckels	100	-	-	-	-	94	94	-	94	89	90
Tulare Lake	"	100	-	-	99	-	101	101	-	91	85	87
Yettiem	"	100	-	-	-	-	-	-	-	92	94	-
Visalia	Holly	100	-	-	103	101	-	-	-	-	-	-
North Tracy	"	100	-	98	103	99	-	-	-	-	94	97
<u>Imperial Valley</u>												
Brawley - Early	USDA	100	101	102	100	102	100	102	100	98	98	99
Brawley - Late	"	100	99	102	100	101	-	-	100	98	97	98
Imp. Val. - 1st bar.	Holly	100	-	-	99	-	-	-	-	-	97	99
" - 2nd "	"	100	-	-	100	-	-	-	-	-	99	99
" - 3rd "	"	100	-	-	100	-	-	-	-	-	97	100

VARIETY TEST, BRAWLEY, CALIFORNIA, 1962-63

Location: U. S. Department of Agriculture, Southwestern Irrigation Field Station.^{1/}

Soil type: Holtville silty clay loam.

Previous crops: Grain sorghum, 1959; sweet sorghum, 1960; Sesbania species cover crop, 1961; fallow, 1962.

Fertilizer used: 100 lbs. per acre P_2O_5 , preplant.
80 lbs. per acre nitrogen, actual, preplant.
145 lbs. per acre nitrogen, actual, sidedressed
October 31, 1962.

Planting date: September 14, 1962.

Thinning date: October 5-8, 1962.

Harvest dates: Early harvest, April 23-24, 1963.
Late harvest, June 6, 1963.

Irrigations: Early harvest, six.
Late harvest, eight.

Diseases and insects: Curly top and yellows viruses were of minor importance in the 1962-63 test. The test plot was sprayed with 2 lbs. DDT per acre September 23, and with 4 oz. Endrin per acre September 29, 1962 for the control of the desert flea beetle and the cabbage beetle. On October 25, 1962, 2 lbs. per acre of Toxaphene was applied for the control of desert flea beetle and webworm. Twenty lbs. per acre of 10 percent Thimet granules was applied on both early and late harvested tests January 14, 1963. A second application of Thimet was made on the late harvested test February 27, 1963 for the control of aphids and spider mites.

Experimental design: Ten varieties planted in a 10 x 10 latin square, two-row plots; and a randomized block test with ten replications, single-row plots, for early harvest. Ten varieties planted in a 10 x 10 latin square, two-row plots, for late harvest. Rows spaced 30 inches apart. Plots 40 feet long.

Sugar analysis: From two ten-beet samples per plot by Holly Sugar Corporation, Brawley, California.

Remarks: Test designed and results analyzed by the United States Agricultural Research Station, Salinas, California.

1/ Plot under supervision of K. D. Beatty stationed at Southwestern Irrigation Field Station, Brawley, California.

VARIETY TEST, BRAWLEY, CALIFORNIA, 1963

Planted: September 13-14, 1962

Harvested: April 23, 1963

(10 x 10 Latin Square)

Variety No.	Description	Acre Yield		Sucrose Percent	Harvest Count Number
		Sugar Pounds	Beets Tons		
263TH1	(MS of NB1 x NB3) x 663 Tetra	8,550	24.42	17.5	129
263TH2	(MS of NB1 x NB5) x 663 Tetra	8,400	24.16	17.4	129
264H1	(MS of NB1 x NB5) x 663 (NB)	8,280	23.25	17.8	127
263TH4	(562HO x 569) x 663 Tetra	8,230	23.42	17.6	140
063H1	(MS of NB1 x NB3) x 663	8,190	22.96	17.9	141
163H2	(MS of NB1 x NB5) x 663	8,070	22.63	17.8	142
1539H1	(515HO x 569) x NB7	8,050	22.23	18.1	125
2539H4	(562HO x 569) x NB7	7,900	21.86	18.1	135
263H4	(562HO x 569) x 663	7,580	21.35	17.8	124
263TH3	(515HO x 569) x 663 Tetra	7,510	21.27	17.8	115

General MEAN of all varieties	8,080	22.75	17.8	Beets
S. E. of MEAN	127	0.39	0.11	per
Significant Difference (19:1)	359	1.11	0.30	100'
S. E. of MEAN in % of MEAN	1.57	1.72	0.60	row

Odds 19:1 = $2.00 \times \sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	M E A N S Q U A R E S		
		Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	9	1,120,563	11.96	0.54
Between replications	9	356,051	5.77	2.28
Between columns	9	375,615	3.52	0.39
Remainder (Error)	72	161,532	1.53	0.11

Total 99

Calculated F value 6.94** 7.82** 4.74**

** Exceeds the 1% point of significance (F=2.67)

VARIETY TEST, BRAWLEY, CALIFORNIA, 1963

(10 x 10 Latin Square)

Planted: September 13-14, 1962

Harvested: June 6, 1963

Variety	Description	Acre Yield		Sucrose Percent	Harvest Count Number
		Sugar Pounds	Beets Tons		
263TH1	(MS of NB1 x NB3) x 663 Tetra	11,370	33.7	17.0	135
263TH2	(MS of NB1 x NB5) x 663 Tetra	11,060	33.1	16.8	131
263TH4	(562HO x 569) x 663 Tetra	10,680	31.3	17.1	144
264H1	(MS of NB1 x NB5) x 164	10,450	30.3	17.4	136
063H1	(MS of NB1 x NB3) x 663	10,440	30.5	17.3	139
163H2	(MS of NB1 x NB5) x 663	10,350	30.0	17.4	143
1539H1	(515HO x 569) x NB7	10,320	29.2	17.8	149
263TH3	(515HO x 569) x 663 Tetra	10,230	29.9	17.3	123
263H4	(562HO x 569) x 663	9,900	28.8	17.4	126
2539H4	(562HO x 569) x NB7	9,390	26.9	17.6	144

General MEAN of all varieties	10,420	30.4	17.3	Beets per 100' row
S. E. of MEAN	173	0.54	0.14	
Significant Difference (19:1)	490	1.52	0.40	
S. E. of MEAN in % of MEAN	1.66	1.77	0.82	

Odds 19:1 = 2.00 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	M E A N S Q U A R E S		
		Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	9	3,079,860	39.74	0.84
Between replications	9	719,242	9.83	0.50
Between columns	9	806,254	95.69	18.27
Remainder (Error)	72	300,297	2.89	0.20
Total	99			
Calculated F value		10.26**	13.75**	4.14**

** Exceeds the 1% point of significance (F=2.67)

VARIETY TEST, BRAWLEY, CALIFORNIA, 1963

(10 replications of each variety)

Planted: September 13-14, 1962

Harvested: April 24, 1963

Variety No.	Description	Acre Yield		Sucrose Percent	Harvest Count Number
		Sugar Pounds	Beets Tons		
163H2	(MS of NB1 x NB5) x 663	8,530	23.70	18.02	139
2954-6H1	(569HO x 562) x E10/59	8,270	23.38	17.69	135
2954-4H1	(569HO x 562) x D38/59	8,260	23.77	17.39	131
263H6	(515HO x 562) x 663	8,260	22.88	18.09	123
2954-2H1	(569HO x 562) x D13/59	8,240	24.01	17.17	130
263H7	(561HO x 569) x 663	8,200	22.84	17.96	133
263H8	(569HO x 562) x 663	8,070	22.71	17.81	128
163H5	(515HO x 569) x 663	7,830	21.93	17.86	136
F57-63	Inc. 663	7,560	21.06	17.98	128
2539H6	(515HO x 562) x NB7	7,420	20.20	18.40	133
2539H8	(569HO x 562) x NB7	7,290	19.66	18.52	132
264	Bolt. res. sel. 663	7,080	19.99	17.77	116
011	Yel. res. sel. 368	7,000	19.79	17.72	129
368	US 75	6,450	18.13	17.82	129
General MEAN of all varieties		7,750	21.72	17.87	Beets per 100' row
S. E. of MEAN		236	0.69	0.18	
Significant Difference (19:1)		661	1.93	0.50	
S. E. of MEAN in % of MEAN		3.05	3.17	2.79	

Odds 19:1 = 1.98 x $\sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	M E A N S Q U A R E S		
		Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	13	3,854,341	35.70	1.22
Between replications	9	819,131	6.47	2.75
Remainder (Error)	117	556,358	4.73	0.32
Total	139			
Calculated F value		6.93**	7.55**	3.81**

** Exceeds the 1% point of significance (F=2.30)

VARIETY TEST, SALINAS, CALIFORNIA, 1963

Location: Spence Field of the U. S. Agricultural Research Station.

Soil type: Sandy loam.

Previous crops: Fallow, 1960; barley cover crop, 1961; vetch cover crop, 1962.

Fertilizer used: 500 lbs. per acre 10:10:5, preplant.
220 lbs. per acre ammonium sulfate sidedressed
March 5, 1963.
200 lbs. per acre ammonium sulfate sidedressed
April 30, 1963.

Planting date: Bolting test, planted November 15, 1962.
Yield test, planted December 11, 1962.

Thinning date: Bolting test, December 27, 1963.
Yield test, January 8, 1963.

Harvest date: Bolting test, September 16-17, 1963.
Yield test, September 17-20, 1963.

Irrigations: Sprinkler irrigation as required up to April 25, 1962.
Subsequently, furrow irrigation used at about ten-day intervals.

Diseases and insects: Infection with yellows viruses and mosaic approached 100 percent by late June. Test plots were sprayed once with Dylox plus brown sugar for the control of leaf miner.

Experimental design: Randomized block with four replications for the November, 1962 planting. Varieties planted in two-row plots; plots 35 feet long. Randomized block with eight replications for the December, 1962 planting. Varieties planted in two-row plots with rows spaced 28 inches apart. Plots 60 feet long.

Sugar analysis: From two ten-beet samples per plot by Spreckels Sugar Company, Spreckels, California.

VARIETY TEST, SALINAS, CALIFORNIA, 1963

(4 replicated plots of each variety)

Planted: November 15, 1962

Harvested: September 16-17, 1963

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Harvest Count
		Sugar Pounds	Beets Tons			
263TH2	(MS of NB1 x NB5) x 663 Tetra	13,690	45.1	15.2	7.6	129
263TH1	(MS of NB1 x NB3) x 663 Tetra	13,590	44.3	15.4	8.0	123
263TH3	(515HO x 569) x 663 Tetra	13,250	43.3	15.4	10.0	143
F60-554H1	MS of NB1 x NB4	13,180	41.2	16.0	10.7	127
264H1	(MS of NB1 x NB5) x 264	13,060	42.1	15.5	21.0	136
263TH4	(562HO x 569) x 663 Tetra	12,820	43.3	14.9	4.6	119
263H4	(562HO x 569) x 663	12,750	38.6	16.5	12.6	133
163H5	(515HO x 569) x 663	12,600	39.6	15.9	23.4	134
2539H1	(515HO x 569) x NB7	12,380	41.1	15.1	28.2	134
1539H1	(515HO x 569) x NB7	12,320	41.6	14.8	22.4	137
263H6	(515HO x 562) x 663	12,310	38.6	16.0	18.6	135
F62-63T	663 Tetraploid	12,260	42.0	14.7	1.2	126
163H2a	(MS of NB1 x NB5) x 663	12,100	39.8	15.2	14.1	139
087H1	(MS of NB5 x NB6) x 787	12,090	39.7	15.2	5.7	133
263H7	(561HO x 569) x 663	12,000	37.9	15.9	11.3	139
263H1	(MS of NB1 x NB3) x 663	11,970	39.2	15.3	18.6	108
263H8	(569HO x 562) x 663	11,860	37.4	15.9	12.7	133
2539H6	(515HO x 562) x NB7	11,740	39.8	14.8	20.1	129
2539H4	(562HO x 569) x NB7	11,630	36.7	15.8	13.0	125
F60-547H1	MS of NB1 x NB5	11,610	36.5	15.9	14.7	126
063H3	(MS of NB1 x NB4) x 663	11,490	38.2	15.1	12.4	134
1547H1	MS of NB1 x NB5	11,460	36.0	15.9	7.4	135
011	Yel. res. sel. 368	11,440	36.1	15.9	14.0	120
F60-512H1	MS of NB5 x NB6	11,420	38.8	14.7	4.7	136
2539H8	(569HO x 562) x NB7	11,320	37.2	15.2	23.7	126
264	Bolt. res. sel. 663	11,320	35.5	16.0	16.5	143
2546-36H1	562HO x 546-36	10,780	36.0	15.0	12.9	133
2546-8H1	562HO x 546-8	10,780	33.9	15.9	7.5	115
663	(US15 x US22/3) Sel.	10,640	34.4	15.5	6.8	133
F59-569H1	515HO x 569	10,540	31.9	16.6	34.9	136
F61-569H3	562HO x 569	10,400	33.0	15.8	9.7	123
F62-546H1	562HO x 546	10,370	31.9	16.2	9.2	126
F62-569H3	562HO x 569	10,140	32.3	15.7	12.9	125
F62-569H3A	562HO x 569	10,090	30.4	16.6	12.6	122
368	US 75	10,030	31.7	15.9	8.9	142
F58-85HO	85HO x 85	8,010	26.2	15.2	2.5	139

General MEAN of all varieties	11,650	37.5	15.6	13.2	Beets per 100' row
S. E. of MEAN	419	1.40	0.34	2.26	
Significant Difference (19:1)	1,175	3.94	0.97	6.33	
S. E. of MEAN in % of MEAN	3.6	3.7	2.2	17.2	

Odds 19:1 = $1.98 \times \sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	MEAN SQUARES			
		Gross Sugar	Tons Beets	Percent Sucrose	Percent Bolting
Between varieties	35	5,571,481	73.18	1.11	214.36
Between replications	3	1,504,190	44.70	2.29	19.30
Remainder (Error)	105	701,122	7.88	0.48	20.40

Total 143

Calculated F value 7.95** 9.29** 2.34** 10.51**

** Exceeds the 1% point of significance (F=1.84)

VARIETY TEST, SALINAS, CALIFORNIA, 1963

(10 replicated plots of each variety)

Planted: December 11, 1962

Harvested: September 17-19, 1963

Variety	Description	Acre Yield		Sucrose Percent	Bolting Percent	Harvest Count Number
		Sugar Pounds	Beets Tons			
263TH2	(MS of NBL x NB5) x 663 Tetra	13,300	43.1	15.5	3.8	145
263TH1	(MS of NBL x NB3) x 663 Tetra	12,900	41.9	15.5	3.5	138
263TH4	(562HO x 569) x 663 Tetra	12,780	41.9	15.4	2.1	143
264H1	(MS of NBL x NB5) x 264	12,730	39.0	16.4	15.5	133
263H4	(562HO x 569) x 663	12,460	39.5	15.8	4.9	129
163H2a	(MS of NBL x NB5) x 663	12,400	40.4	15.4	6.3	162
2539H4	(562HO x 569) x NB7	12,280	39.9	15.5	9.4	141
2539H1	(515HO x 569) x NB7	12,220	39.4	15.6	20.4	141
263H8	(569HO x 562) x 663	12,190	40.2	15.2	6.6	143
263H7	(561HO x 569) x 663	12,140	39.2	15.5	5.2	134
163H5	(515HO x 569) x 663	11,980	37.6	16.0	14.0	137
063H3	(MS of NBL x NB4) x 663	11,960	39.3	15.2	5.7	156
263H6	(515HO x 562) x 663	11,660	37.5	15.6	10.7	117
263H1	(MS of NBL x NB3) x 663	11,620	37.3	15.6	9.3	146
2539H6	(515HO x 562) x NB7	11,520	38.7	15.0	22.0	136
General MEAN of all varieties		12,280	39.7	15.5	9.3	Beets per 100' row
S. E. of MEAN		271	0.79	0.20	1.09	
Significant Difference (19:1)		759	2.20	0.57	3.03	
S. E. of MEAN in % of MEAN		2.2	2.0	1.3	11.6	

Odds 19:1 = $1.976 \times \sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	M E A N S Q U A R E S			
		Gross Sugar	Tons Beets	Percent Sucrose	Percent Bolting
Between varieties	14	2,509,753	28.04	1.17	377.2
Between replications	9	1,854,898	108.31	20.75	9.8
Remainder (Error)	126	737,031	6.20	0.41	11.8
Total	149				
Calculated F value		3.41**	4.52**	2.86**	31.97**

** Exceeds the 1% point of significance (F=2.20)

VARIETY TEST, CLARKSBURG, CALIFORNIA

California Test #3 - 1963

		By American Crystal Sugar Co.			
Variety	Description	Acre Yield		Sucrose	Harvest
		Sugar	Beets		Count
		Pounds	Tons	Percent	Number
62-4T23 H15	(561 x 569) x 163T	7413	31.98	11.67	128
61-4T9 H7	61-Triploid	7137	26.67	13.41	131
62-4T32 H14	(515 x 569) x 163T	6946	30.23	11.59	134
62-4T32 H11	(515 x 562) x 163T	6806	29.18	11.60	129
263 TH4	(562 x 569) x 163T	6446	26.86	12.20	145
61-4T9 H15	61-Triploid	6334	24.04	13.15	123
263 H7	(561 x 569) x 663	6052	24.10	12.52	141
163 H2a	(1 x 5) x 663	5976	24.09	12.35	141
263 H4	(562 x 569) x 663	5802	23.15	12.48	114
Am #5-H1	(1 x 5) x 58-205-0 Com'l	5717	22.84	12.40	138
263 H6	(515 x 562) x 663	5661	22.92	12.38	126
163 H5	(515 x 569) x 663	5442	21.65	12.57	146
2539 H4	(562 x 569) x NB7	5306	22.15	11.78	123
1539 H3	F60-561 HO x NB7	5141	21.59	11.95	133
2539 H1	(515 x 569) x NB7	4752	20.33	11.85	123
2539 H6	(515 x 562) x NB7	4574	19.50	11.64	119
General Mean		5969	24.45	12.21	131
LSD (0.05)		791	3.19	.58	17.2
LSD (0.01)		1048	4.24	.77	22.4
Calculated F Value		10.72**	12.73**	10.38**	2.51**
C. V. %		13.32	13.16	4.77	13.07
Efficiency		124%	123%	121%	—

** Exceeds the 1% point of significance (F=2.28)

Cooperator: L. F. Olson

Location: Dixon

Planted: March 13, 1963

Harvested: September 23-24, 1963

Experimental Design: 4 x 4 Simple Lattice Repeated 4 times.

Comparison of 2n and 3n Hybrids of the Same Parental Material

	Acre Yield		Sucrose Percent	Harvest Count Number	Number of Comparisons
	Sugar	Beets			
	Pounds	Tons			
Diploid	5739	22.96	12.49	132	4
Triploid	6903	29.56	11.76	134	4

DATA ON U.S.D.A. VARIETIES TESTED BY SPRECKELS SUGAR COMPANY, 1963

TEST AREAS: V a r i e t y	SPRECKELS			SPRECKELS			SPRECKELS			SPRECKELS			ALISAL			GREENFIELD		
	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar
263H4	4.749	35.14	13.5	4.118	31.18	13.4												
263H6	4.624	35.08	13.2															
263H8	4.567	34.89	13.1	3.213	29.28	11.0												
263H7	4.450	33.89	13.2															
2539H1	4.430	33.83	13.1															
2539H8	4.374	33.64	13.1															
2539H6	4.339	34.67	12.6															
2539H4	4.326	32.74	13.2															
USH6	4.312	33.61	12.9															
263TH4				4.590	36.10	12.9												
F59-63H1				4.724	36.61	13.1												
263TH2				4.477	34.37	13.0												
263TH1				4.135	33.89	12.2	3.351	32.10	10.4									
2539H1				4.058	33.12	12.3												
163H5							3.946	36.14	10.9									
0539H1							3.694	32.32	11.4									
1539H1																		
163H6																		
663H1																		
							4.373	31.352	14.0									
										5.115	36.84	13.9				5.957	35.07	17.0
										4.761	32.43	14.7				5.560	32.26	17.2
Planting Date	December 5, 1962			December 5, 1962			January 8, 1963			January 8, 1963			January 7, 1963			December 31, 1962		
Harvest Date	August 26, 1963			September 4, 1963			September 6, 1963			September 6, 1963			August 28, 1963			September 5, 1963		
GENERAL MEAN	4.380	33.93	12.9	3.929	31.56	12.5	3.682	33.30	11.0	3.969	28.13	14.1	5.017	35.33	14.2	5.333	31.60	16.9
LSD @ P = .05	NS	NS	NS	0.625	5.21	0.70	0.403	3.97	0.55	-----	-----	-----	-----	-----	-----	-----	-----	-----
LSD @ P = .01	NS	NS	NS	0.822	6.85	0.92	0.534	5.26	0.70	-----	-----	-----	-----	-----	-----	-----	-----	-----
S E of Mean	0.189	1.394	0.317	0.225	1.88	0.25	0.144	1.411	0.198	-----	-----	-----	-----	-----	-----	-----	-----	-----
S E % of Mean	4.32	4.11	2.46	5.736	5.95	2.01	3.91	4.24	1.80	-----	-----	-----	-----	-----	-----	-----	-----	-----
# Var. In Test	Twelve			Eighteen			Fourteen			Twelve			Eight			Ten		

DATA ON U.S.D.A. VARIETIES TESTED BY SPRECKELS SUGAR COMPANY, 1963

TEST AREAS: Variety	TULARE LAKE			KERN COUNTY			KERN COUNTY			CROWS LANDING			YETTEM		
	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar	Sugar T/Ac.	Beets T/Ac.	% Sugar
263H-6	4.306	28.73	15.0				3.38	23.8	14.2	3.838	32.45	12.0			
263H-4	4.475	30.37	14.8							4.028	36.03	11.4			
263TH-4	4.306	33.34	12.9							3.896	33.23	12.0	3.57	24.8	14.4
263TH-1	4.256	31.53	13.5							4.043	36.24	11.3	3.53	24.0	14.7
263TH-2	4.209	33.17	12.7							3.710	31.94	11.9			
2539H-6	3.912	25.88	15.1												
USH6	4.036	26.95	14.9	4.75	34.9	13.6	3.25	22.6	14.4	3.849	31.25	12.7	4.07	25.9	15.7
US 75	3.113	20.98	14.9				2.59	18.1	14.3	2.691	22.60	12.2			
263H8				5.15	35.5	14.5									
GEN. MEAN	4.021	27.96	14.4	4.56	32.9	13.9	2.99	21.1	14.1	3.722	30.85	12.3	3.40	22.0	15.3
ISD (5%)	0.478	3.01	0.67							0.569	5.27	0.97			
PLANTING DATE	January 23, 1963			February 5, 1963			January 11, 1963			January 10, 1963			January 18, 1963		
# Varieties in Test	Sixteen			Sixteen			Sixteen			Fifteen			Sixteen		
HARVEST DATE	August 29, 1963			August 8, 1963			July 8, 1963			September 4, 1963			July 30, 1963		

VARIETY TEST, BETTERAVIA, CALIFORNIA, 1963

Grower and location: R. N. Winters, Guadalupe, California.

Soil type: Sandy loam.

Previous crops: Broccoli (2 crops), 1960; beans, 1961; potatoes, 1962.

Fertilizer used: 100 lbs. per acre NH_3 , preplant.
100 lbs. per acre NH_3 , sidedressing.

Planting date: January 14, 1963.

Thinning date: March 1, 1963.

Harvest date: October 1, 1963.

Irrigations: Four.

Diseases and insects: Not a factor in the test plot.

Experimental design: Randomized block with eight replications.
Varieties planted on double-row beds with 40-inch centers. Plots
60 feet long.

Sugar analysis: From two ten-beet samples per plot by Union Sugar
Division, Betteravia, California.

Remarks: Seed was furnished, test designed, and results analyzed by
United States Agricultural Research Station, Salinas, California.
Appearance of test plot shortly before harvest indicated nitrogen
deficiency in that part of the field in which test plot was
located. The extremely high sugar percentages tend to substantiate
this probability.

VARIETY TEST, BETTERAVIA, CALIFORNIA, 1963

(8 replications of each variety)

By Union Sugar Division

Variety	Description	Acre Yield		Sucrose Percent	Harvest Count
		Sugar Pounds	Beets Tons		
263TH2	(MS of NB1 x NB5) x 663 Tetra	12,550	34.8	18.1	142
263TH3	(515HO x 569) x 663 Tetra	12,420	34.3	18.1	145
163H2	(MS of NB1 x NB5) x 663	12,360	34.0	18.2	149
263H4	(562HO x 569) x 663	11,830	32.7	18.1	147
063H3	(MS of NB1 x NB4) x 663	11,720	32.3	18.1	151
263H6	(515HO x 562) x 663	11,680	32.2	18.2	154
2539H1	(515HO x 569) x NB7	11,640	32.5	17.9	146
2539H6	(515HO x 562) x NB7	11,630	33.1	17.6	146
2539H4	(562HO x 569) x NB7	11,420	32.3	17.7	149
163H5	(515HO x 569) x 663	11,280	31.4	18.0	153
General MEAN of all varieties		11,850	33.0	18.0	Beets
S. E. of MEAN		303	0.86	0.13	per
Significant Difference (19:1)		858	N.S.	0.37	100'
S. E. of MEAN in % of MEAN		2.6	2.6	0.7	row

Odds 19:1 = $2 \times \sqrt{2} \times \text{Standard Error of MEAN}$

VARIANCE TABLE

Variation due to	Degrees of Freedom	M E A N S Q U A R E S		
		Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	9	1,532,627	9.18	0.36
Between replications	7	3,897,363	35.65	0.70
Remainder (Error)	63	736,559	5.89	0.14
Total	79			

Calculated F value 2.08* N.S. 2.54*

* Exceeds the 5% point of significance (F=2.03)

VARIETY TEST, SAN ARDO, CALIFORNIA, 1963

Grower and location: Hansen and Fowler, San Ardo, California.

Soil type: Sandy loam.

Previous crops: Alfalfa, 1960; sugarbeets, 1961; tomatoes, 1962.

Fertilizer used: 400 lbs. per acre 12:15:0, preplant.
250 lbs. per acre 32:0:0, (liquid) sidedressed in
one application.

Planting date: January 8, 1963.

Thinning date: March 7, 1963.

Harvest date: September 11, 1963.

Irrigations: A total of four, the first, May 16, and the last,
July 24, 1963.

Diseases and insects: Not a factor in the test plot.

Experimental design: Ten varieties planted in a 10 x 10 latin square.
Varieties planted on double-row beds with 40-inch centers. Plots
60 feet long.

Sugar analysis: From two ten-beet samples per plot by Union Sugar
Division, Betteravia, California.

Remarks: Test plot was hand thinned and remainder of field machine
thinned. The field yielded an average of 33.31 tons per acre
with an average of 16.54 percent sucrose. The variety was US H2.
Seed for the test plot was furnished, the test designed and the
results analyzed by the United States Agricultural Research Station,
Salinas, California.

VARIETY TEST, SAN ARDO, CALIFORNIA, 1963

10 x 10 Latin Square

By Union Sugar Division

Variety	Description	Acre Yield		Sucrose Percent	Harvest Count
		Sugar Pounds	Beets Tons		
263TH2	(MS of NB1 x NB5) x 663 Tetra	14,010	40.7	17.2	145
163H2	(MS of NB1 x NB5) x 663	13,750	39.2	17.6	161
263H4	(562HO x 569) x 663	13,620	38.7	17.6	152
263H8	(569HO x 562) x 663	13,410	38.0	17.6	163
2539H6	(515HO x 562) x NB7	13,340	38.1	17.5	157
263H1	(MS of NB1 x NB3) x 663	13,150	37.7	17.5	155
163H5	(515HO x 569) x 663	12,980	36.5	17.8	170
2539H1	(515HO x 569) x NB7	12,930	36.7	17.6	156
263H6	(515HO x 562) x 663	12,790	36.2	17.7	152
2539H4	(562HO x 569) x NB7	12,680	36.8	17.2	157
General MEAN of all varieties		13,260	37.9	17.5	Beets per 100' row
S. E. of MEAN		287	0.61	0.11	
Significant Difference (19:1)		813	1.71	0.31	
S. E. of MEAN in % of MEAN		2.2	1.6	0.6	

Odds 19:1 = $1.994 \times \sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	M E A N S Q U A R E S		
		Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	9	1,908,178	19.45	0.33
Between replications	9	608,970	6.98	0.12
Between columns	9	1,437,663	29.86	1.65
Remainder (Error)	72	832,374	3.69	0.12

Total 99

Calculated F value 2.29* 5.28** 2.71**

* Exceeds the 5% point of significance (F=2.01)

** Exceeds the 1% point of significance (F=2.67)

VARIETY TEST, KING CITY, CALIFORNIA, 1963

Grower and location: A. S. Duarte, King City, California.

Soil type: Salinas clay.

Previous crops: Tomatoes, 1960; lettuce, 1961; carrots, 1962.

Fertilizer used: 300 lbs. per acre 16:20:0, preplant.
400 lbs. per acre ammonium sulfate, sidedressed in
one application.

Planting date: February 28, 1963.

Thinning date: April 10, 1963.

Harvest date: October 29-30, 1963.

Irrigations: Six.

Diseases and insects: Diseases and insect damage were of minor
importance in the 1963 test plots. Nematode damage was
moderately severe throughout the 1963 test plot area.

Experimental design: One test of 10 varieties planted in a 10 x 10
latin square; and a test of 10 varieties replicated four times.
Varieties planted on double-row beds with 40-inch centers.
Plots 60 feet long.

Sugar analysis: From two ten-beet samples per plot by Union Sugar
Division, Betteravia, California.

Remarks: Seed was furnished, test designed, and results analyzed by
the United States Agricultural Research Station, Salinas, California.

VARIETY TEST, KING CITY, CALIFORNIA, 1963

(10 x 10 Latin Square)

By Union Sugar Division

Variety	Description	Acre Yield		Sucrose Percent	Harvest Count Number
		Sugar	Beets		
		Pounds	Tons		
263TH1	(MS of NB1 x NB3) x 663 Tetra	8,830	23.7	18.6	124
263TH2	(MS of NB1 x NB5) x 663 Tetra	8,790	23.8	18.5	132
263H4	(562H0 x 569) x 663	8,460	22.5	18.8	151
163H5	(515H0 x 569) x 663	8,420	22.1	19.2	155
264H1	(MS of NB1 x NB5) x 164	8,240	21.8	18.9	135
263H1	(MS of NB1 x NB3) x 663	8,210	21.8	18.8	153
163H2	(MS of NB1 x NB5) x 663	8,120	21.7	18.8	159
2539H1	(515H0 x 569) x NB7	7,990	21.2	18.9	158
2539H4	(562H0 x 569) x NB7	7,960	21.4	18.6	155
2539H6	(515H0 x 562) x NB7	7,840	21.1	18.6	144
General MEAN of all varieties		8,290	22.1	18.8	Beets per 100' row
S. E. of MEAN		257	0.63	0.16	
Significant Difference (19:1)		N.S.	1.77	N.S.	
S. E. of MEAN in % of MEAN		3.1	2.9	0.9	

Odds 19:1 = $1.994 \times \sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	M E A N S Q U A R E S		
		Gross	Tons	Percent
		Sugar	Beets	Sucrose
Between varieties	9	1,131,593	9.16	0.37
Between replications	9	1,817,252	16.07	1.37
Between columns	9	269,139	7.37	1.10
Remainder (Error)	72	658,185	3.96	0.25
Total	99			
Calculated F value		N.S.	2.31*	N.S.

* Exceeds the 5% point of significance (F=2.01)

VARIETY TEST, KING CITY, CALIFORNIA, 1963

(4 replicated plots of each variety)

By Union Sugar Division

Variety	Description	Acre Yield		Sucrose Percent	Harvest Count Number
		Sugar	Beets		
		Pounds	Tons		
263TH4	(562HO x 569) x 663 Tetra	9,570	25.8	18.5	148
263H7	(561HO x 569) x 663	9,180	24.3	18.9	147
163H2	(MS of NB1 x NB5) x 663	8,900	25.0	17.9	148
263H6	(515HO x 562) x 663	8,840	23.9	18.5	153
011	V. Y. sel. from US 75	8,390	22.6	18.6	137
263H8	(569HO x 562) x 663	8,290	22.0	18.8	156
F57-68	US 75	8,060	21.9	18.5	156
F62-546H1	562HO x 546	7,970	21.1	18.9	138
F62-569H3	562HO x 569	7,470	19.9	18.8	160
2546-8H1	562HO x 546-8	7,450	20.7	18.0	124
General MEAN of all varieties		8,410	22.7	18.5	Beets per 100' row
S. E. of MEAN		322	0.80	0.33	
Significant Difference (19:1)		935	2.31	N.S.	
S. E. of MEAN in % of MEAN		3.8	3.51	1.76	

Odds 19:1 = $2.052 \times \sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	M E A N S Q U A R E S		
		Gross Sugar	Tons Beets	Percent Sucrose
Between varieties	9	2,005,120	15.38	0.52
Between replications	3	1,216,614	9.00	0.90
Remainder (Error)	27	415,236	2.54	0.43
Total	39			

Calculated F value 4.83** 6.06** N.S.

** Exceeds the 1% point of significance (F=3.14)

PURITY ANALYSIS, KING CITY, BETTERAVIA AND WATSONVILLE VARIETY TESTS, 1962

(See pages 31-36, 1962 Report, for yield data and sucrose percentage)

Variety	Description	Purity			
		King City		Betteravia	
		Test 1 Percent	Test 2 ^a Percent	Percent	Percent
1539H1	(515H0 x 569) x NB7 (2n)	90.9	93.8		
0546-22H1	85H0 x 546-22 (2n)	90.7			
163TH2	(MS of NBL x NB3) x 663 Tetra	90.5		86.5	90.8
163H2	US H6 (2n)	91.1	92.7		
063H1	US H2 (2n)	91.2	92.9	87.1	92.0
0562H2	85H0 x 562 (2n)	90.1			
163H2a	US H6 (New) (2n)	91.7			
163H5	(515H0 x 569) x 663 (2n)	90.4			
163H6	(515H0 x 562) x 663 (2n)	90.8			
163H4	(515H0 x 561) x 663 (2n)	90.6			
1970H2	(MS of NBL x NB3) x H9394		93.2		
063H3	US H5 (2n)		92.6		
1964H2	(MS of NBL x NB5) x H7366		92.0		
1958H2	(MS of NBL x NB5) x H6370		92.1		
1968H2	(MS of NBL x NB3) x H9368		92.0		
1954-1H2	(MS of NBL x NB5) x D10/59		92.2		
1960H2	(MS of NBL x NB5) x H6351		92.7		
1954-4H2	(MS of NBL x NB5) x D38/59		92.3		
1956H2	(MS of NBL x NB5) x H18		91.7		
1963H2	(MS of NBL x NB5) x H5261		91.3		
1962H2	(MS of NBL x NB5) x H5338		92.5		
1955H2	(MS of NBL x NB5) x H3608		91.1		
1954-6H2	(MS of NBL x NB5) x =10/59		91.8		
1967H2	(MS of NBL x NB3) x H9355		92.6		
1963H1	(515H0 x 569) x H5261		91.4		
1961H1	(515H0 x 569) x H6354		91.2		
1956H1	(515H0 x 569) x H18		91.6		

MEAN

90.8
N.S.

92.2
N.S.

N.S.

0.74

^a/ King City triploid evaluation test.

Variety Test

1962-63

Imperial Valley, Calif.

1st Date of Harvest

Coop: Nelson Correll

Variety	Source or Description	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	% Bolt.	No. Beets 100' Row
L2379	F60-547H1 x 163rr T3n	7498	23.986	15.63	96.26		161
L2473	F61-569H3 x C663	7388	23.101	15.99	95.68		159
L2368	547H1 x 663	7201	22.281	16.16	96.08		189
USH4	L1343	7026	21.434	16.39	96.36	.06	193
L2381	F61-569H3 x 163rr T3n	6928	21.760	15.92	96.11		177
US75	L9252	6841	22.038	15.52	95.89		178
Gen. Mean		7135	22.376	15.95	96.26		180
SEmean		135A/	.403	.09	.29		
LSD (5%)		379	1.132	.26	.70		
SEm/Gen. Mean (%)		1.89	1.80	.57	.26		

Variation Due To	DF	Mean Squares		
		Tons Beets	% Sucrose	% T.J.P.
Replication	8	36.377	1.858	3.081
Variety	15	9.847	.733	.983
Error	120	1.465	.075	.557
Total	143			
Calc. F.		6.72**	9.81**	NS

A/ Short Cut Formula

** Exceeds 1% Level 2.26

NS Not Significant

Design: 4 x 4 Triple Lattice - 9 reps.

Plot Size: 2 rows (34") x 53' Planted
2 rows x 50' Harvested

Planted: September 13, 1962

Harvested: April 18, 1963

Remarks: Excellent test. Only scattered yellows infected plants visible.

Variety Test

1962-63

Imperial Valley, Calif.

2nd Date of Harvest

Coop: Nelson Correll

Variety	Source or Description	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	% Bolt.	% C.T.	No. Beets 100' Row
L2379	F60-547H1 x 163rr T3n	10912	31.628	17.25	95.17	.09	4.94	138
L2368	547H1 x 663	10377	29.683	17.48	95.12	.20	3.91	173
L2473	F61-569H3 x 0663	10282	29.309	17.54	94.47	.26	7.99	143
USH4	L1343	10202	28.402	17.96	95.13	.55	1.59	167
L2381	F61-569H3 x 163rr T3n	10151	29.321	17.31	95.16		4.95	162
US75	L9252	9178	27.528	16.67	94.62	.49	2.23	165
Gen. Mean		10018	28.832	17.38	95.10			162
SEmean		222A/	.606	.12	.24			
LSD (5%)		623	1.700	.34	.67			
SEm/Gen. Mean (%)		2.22	2.10	.70	.25			

Variance Table

Variation Due To	DF	Tons Beets	Mean Squares % Sucrose	% T.J.P.
Replication	8	146.053	3.148	3.655
Variety	15	14.232	1.345	1.105
Error	120	3.306	.134	.518
Total	143			
Calc. F.		4.42**	10.22**	2.13*

A/ Short Cut Formula

** Exceeds 1% Level 2.26

* Exceeds 5% Level 1.79

Design: 4 x 4 Triple Lattice - 9 reps.

Plot Size: 2 rows (34") x 53' Planted
2 rows x 50' Harvested

Planted: September 13, 1962

Harvested: June 7, 1963

Variety Test

1962-63

Imperial Valley, Calif.

3rd Date of Harvest

Coop: Nelson Correll

Variety	Source or Description	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	% Bolt.	No. Beets 100' Row
USH4	L1343	9553	27.804	17.18	94.83	1.23	156
L2379	F60-547H1 x 163rr T3n	9524	29.413	16.19	93.06	.09	134
L2473	F61-569H3 x c663	9512	28.721	16.56	94.17	.41	142
L2381	F61-569H3 x 163rr T3n	8988	27.153	16.56	92.83	.08	151
L2368	547H1 x 663	8796	26.431	16.64	93.47	.45	152
US75	L9252	7196	22.474	16.01	93.00	.41	141
Gen. Mean		8678	25.923	16.74	93.81		153
SEmean		325A/	.945	.14	.47		
LSD (5%)		913	2.650	.41	1.31		
SEm/Gen. Mean (%)		3.75	3.64	.86	.50		

Variance Table

Variation Due To	DF	Tons Beets	Mean Squares % Sucrose	T.J.P.
Replication	8	213.091	1.844	2.544
Variety	15	28.403	1.745	5.181
Error	120	8.031	.188	1.968
Total	143			
Calc. F.		3.54**	9.28**	2.63**

A/ Short Cut Formula

** Exceeds 1% Level 2.26

Design: 4 x 4 Triple Lattice - 9 reps.

Plot Size: 2 rows (34") x 53' Planted
2 rows x 50' Harvested

Planted: September 13, 1962

Harvested: July 19, 1963

The following applies to all test of DP-DH.

Fertilizer: (1) 500 lbs. single super phosphate all preplant.
(2) 100 lbs. NH₃ in December.

Preceding Crops:

1961 - beets
1960 - alfalfa
1959 - alfalfa

(3) Insecticides

8 oz. Endrin + 8 oz. Parathion on October 7 for flea beetles and worms.
20 lbs. 5% Thimet 1-15-63

Remarks: Excellent Test. Mild curly top and occasional yellows only visible diseases.

Variety Test

1962-63

Brawley, California

Early Plant - Early Harvest

Coop: John Fifield

Variety	Source or Description	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	% Bolt.	No. Beets 100' Row
2539H4	F61-569H3 x 0539	6260	22.011	14.22	88.20		141
USH4	L1343	6217	21.617	14.38	87.60		135
263H4	F59-569H3 x 663	6119	21.807	14.03	86.71		130
US75	L9252	5463	20.188	13.53	86.62	.09	129
Gen. Mean		5958	21.387	13.95	87.71		145
SEmean		219A/	.753	.18	.43		
LSD (5%)		610	2.094	.50	1.19		
SEm/Gen. Mean (%)		3.68	3.52	1.30	.49		

Variance Table

Variation Due To	DF	Tons Beets	% Sucrose	% T.J.P.
Replication	8	146.851	24.229	47.002
Variety	41	39.416	2.142	9.936
Error	328	5.097	.294	1.652
Total	377			

Calc. F. 7.73** 7.29** 6.01**

A/ Short Cut Formula

** Exceeds 1% Level 1.69

Design: 6 x 7 Rect. Lattice - 9 reps.

Plot Size: 2 rows (30") x 53' Planted
2 rows x 50' Harvested

Planted: September 11, 1962

Harvested: April 18, 1963

AGRICULTURAL RESEARCH DEPARTMENT * HOLLY SUGAR CORPORATION

Previous Crop History: 1962 - Milo
1961 - Alfalfa
1960 - Alfalfa
1959 - Alfalfa

Fertilizer Applied: 300 lbs. of 11-48-0 - pre-listing time.
120 lbs. of NH₃ - at listing time.
125 lbs. of NH₃ - 10-12-62
125 lbs. of NH₃ - 11-19-62

Pesticides: 7 oz./A. Parathion 9-19-62
8 oz./A. " 9-29-62
15 oz./A. " 10-13-62

Remarks: Fair test. Stands somewhat erratic, due to grass and rot. Some mosaic and yellows present.

Variety Test

1963

Visalia, California

Fall pl. - South San Joaquin

Coop: Vern Dailey

Variety	Source or Description	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	No. Beets 100' Row
2539H4	569H3 x NB7	8494	38.366	11.07		135
263H4	569H3 x 663	7928	34.988	11.33		146
263TH3	L2381 (515 x 569) x 663T	7687	36.227	10.61		127
USH6	(NB1MS x NB5) x 663	7509	34.226	10.97		153
USH4	L0336	7034	30.688	11.46		150
US75	L9252	6403	29.132	10.99		146
Gen. Mean		7432	33.127	11.23		148
SEmean		473A/	1.977	.25		
LSD (5%)		1322	NS	.69		
SEm/Gen. Mean (%)		6.36	5.97	2.21		

Variance Table

Variation Due To	DF	Tons Beets	Mean Squares % Sucrose	% T.J.P.
Replication	8	843.043	24.350	
Variety	19	48.893	1.459	
Error	152	35.188	.554	
Total	179			
Calc. F.		NS	2.64**	

A/ Short Cut Formula

** Exceeds 1% Level 2.00

NS Not Significant

Design: 4 x 5 Rect. lattice - 9 reps.

Plot Size: 2 rows (30") x 53' Planted
2 rows x 50' Harvested

Planted: February 22, 1963

Harvested: September 20, 1963

Remarks: Sandy strip ran through replications 2, 3, 4, and 5, accounting for high replication M.S. Little, if any, disease present.

Variety Test

1963

Merced, California

Spring Plant

Coop: Striblings Nursery

Variety	Source or Description	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	No. Beets 100' Row
USH6	(163H2a) (1 x 5) x 663	5843	17.913	16.31		162
263TH4	569H3 x 4n 663	5832	18.143	15.81		159
USH4	L1343	5733	16.223	17.67		156
Gen. Mean		5795	17.344	16.71		153
SEmean		334A/	.928	.36		
LSD (5%)		934	NS	1.00		
SEm/Gen. Mean (%)		5.76	5.35	2.14		

Variance Table

Variation Due To	DF	Tons Beets	Mean Squares % Sucrose	% T.J.P.
Replication	8	41.709	1.999	
Variety	15	3.806	3.985	
Error	120	7.749	1.146	
Total	143			
Calc. F.		NS	3.48**	

A/ Short Cut Formula

** Exceeds 1% Level 2.15

NS-Not Significant

Design: 4 x 4 Triple Lattice - 9 reps.

Plot Size: 2 rows (30") x 53' Planted
2 rows x 50' Harvested

Planted: March 7, 1963

Harvested: October 2, 1963

Remarks: Excellent test, except yields were restricted by lack of nitrogen during a good portion of the season. Just a few plants infected with yellows and/or mosaic.

Variety Test

1963

North Tracy, Calif.

CTR - North Tracy

Coop: Arnaudo Bros.

Variety	Source or Description	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	No. Beets 100' Row
263H ₁	569H3 x 663	8418	31.622	13.31		129
USH ₁	L1343	8395	31.160	13.47		161
263TH2	(1 x 5) x 4n 663	8283	34.003	12.18		88
2539-H ₁	569H3 x NB7	8194	32.083	12.77		134
263TH ₁	569H3 x 4n 663	8190	32.657	12.54		135
USH6	163H2a (1 x 5) x 663	8184	31.575	12.96		147
US75	L9252	7732	30.299	12.76		151
2539H1	(515 x 569) x NB7	7588	29.992	12.65		130
Gen. Mean		8251	31.608	13.09		147
SEmean		311A/	1.000	.27		
LSD (5%)		868	2.789	.74		
SEm/Gen. Mean (%)		3.77	3.16	2.04		

Variance Table

Variation Due To:	DF	Tons Beets	Mean Squares % Sucrose	% T.J.P.
Replication	8	87.111	24.973	
Variety	29	30.976	2.140	
Error	232	9.006	.641	
Total	269			
Calc. F.		3.44**	3.34**	

A/ Short Cut Formula

** Exceeds 1% Level 1.79

Design: 5 x 6 Triple Rect. Lattice - 9 reps.

Plot Size: 2 rows (30") x 53' Planted
2 rows x 50' Harvested

Planted: May 15, 1963

Harvested: November 14, 1963

Remarks: Excellent test. Harvested under extremely wet conditions. Very little yellows present.

Variety Test

1963

Grimes, California

Coop: Jim Kalsfbeck

Variety	Source or Description	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	No. Beets 100' Row
263THL	569H3 x 4n 663	6878	34.392	10.00		111
USH4	11343	6236	27.763	11.23		109
US75	19252	4591	22.439	10.23		112
Gen. Mean		5929	27.215	10.89		112
SEmean		537A/	2.292	.36		
LSD (5%)		1513	6.462	NS		
SEm/Gen. Mean (%)		9.06	8.42	3.34		

Variance Table

Variation Due To	DF	Mean Squares		
		Tons Beets	% Sucrose	% T.J.P.
Replication	4	100.527	1.821	
Variety	19	62.670	.800	
Error	76	26.267	.662	
Total	99			
Calc. F.		2.39**	NS	

A/ Short Cut Formula

** Exceeds 1% Level 2.15

NS-Not Significant

Design: 4 x 5 Rect. Lattice - 5 reps. analyzed as a randomized block.

Plot Size: 2 rows (30") x 53' Planted
2 rows x 50' Harvested

Planted: May 24, 1963

Harvested: October 30, 1963

Remarks: Four replications near the middle of this were lost due to Sclerotium. No leafspot or yellows. At harvest, top growth excessive and soil moisture great.

Spring Variety Test

1962

Tulare, Calif.

Coop: Bright's Nursery

Variety	Source	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	No. Beets 100' Row
USH6	(NB1M3 x NB5) x 0663	5480	16.496	16.61	95.33	117
USH4	LO336	5076	15.344	16.54	96.18	109
USH2	(NB1M3 x NB3) x 0663	5053	15.760	16.03	94.88	110
1539H1	(515H0 x 569) x 0539	4557	13.223	17.23	94.16	110
1539H2	569H0 x 0539	4273	12.612	16.94	94.98	108
163H6	(515H0 x 562) x 0663	4235	12.801	16.54	93.96	116
Gen. Mean		4799	14.586	16.48	94.18	113
SEmean		401A/	1.192	.28	.45	
LSD (5%)		1118	3.323	.79	1.26	
SEmean/Gen. Mean (%)		8.36	8.17	1.72	.47	

VARIANCE TABLE

Variation Due To	DF	Mean Squares		
		Tons Beets	% Sucrose	% T.J.P.
Replication	8	123.597	2.834	26.267
Variety	29	33.371	1.423	2.872
Error	232	12.784	.723	1.832
Total	269			
Calc. F.		2.61**	1.97**	1.57*

**Exceeds 1% Level 1.79

* Exceeds 5% Level 1.52

A/Short Cut Formula

Design: 5 x 6 Rectangular Lattice - 9 reps.

Plot Size: 2 rows (30") x 50' Planted

2 rows x 47' Harvested

Planted: March 30, 1962

Harvested: August 14, 1962

CTR Variety Test

1962

Tracy, California

Coop: John Paulson

Variety	Source	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	No. Beets 100' Row
USH2	(NB1MS x NB3) x 0663	7084	22.083	16.04	94.60	154
1539H1	(515HO x 569) x 0539	6942	21.694	16.00	95.16	152
USH6	(NB1MS x NB5) x 0663	6820	22.143	15.40	94.62	146
163H6	(515HO x 562) x 0663	6735	20.711	16.26	94.24	151
163H5	(515HO x 569) x 0663	6537	21.034	15.54	94.21	154
1539H2	569HO x 0539	6463	20.876	15.48	94.35	149
USH4	10366	6126	19.227	15.93	94.49	153
US75	10255	5934	19.926	14.89	94.33	149
Gen. Mean		6625	21.054	15.75	94.47	135
SEmean		226A/	.645	.23	.03	
LSD (5%)		630	1.796	.65	.07	
SEmean/Gen. Mean (%)		3.41	3.07	1.48	.27	

VARIANCE TABLE

Variation Due To	DF	Mean Squares		
		Tons Beets	% Sucrose	% T.J.P.
Replication	8	57.308	4.585	11.079
Variety	41	25.505	1.684	1.317
Error	328	3.750	.488	.587
Total	377			
Calc. F.		6.80**	3.15**	2.24**

**Exceeds 1% Level 1.69

A/Short Cut Formula

Design: 6 x 7 Rectangular Lattice - 9 reps.

Plot Size: 2 rows (30") x 53' Planted

2 rows x 50' Harvested

Planted: April 30, 1962

Harvested: October 18, 1962

Variety Test

1962

South San Joaquin

Coop: Ed Irwin

Variety	Source	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	No. Beets 100' Row
USH6	(NE1MS x NB5) x 0663 063H2	4194	14.725	14.24	92.49	170
USH4	10436	4052	14.051	14.42	92.73	170
1539H2	F59-569H0 x 0539 14438	3566	13.100	13.61	93.33	150
US75	10252	3272	12.153	13.46	92.84	149
Gen. Mean		3859	13.951	13.83	92.81	158
SEmean		258A/	.883	.03	.56	
LSD (5%)		724	2.476	.42	1.58	
SEmean/Gen. Mean (%)		6.69	6.33	2.14	6.08	

VARIANCE TABLE

Variation Due To	DF	Mean Squares		
		Tons Beets	% Sucrose	% T.J.P.
Replication	8	836.474	2.954	22.681
Variety	15	14.539	.930	2.581
Error	120	7.010	.791	2.870
Total	143			
Calc. F		2.07*	NS	NS

*Exceeds 5% level 1.79

NS-Not Significant

A/Short Cut Formula

Design: 4 x 4 Triple Lattice - 9 reps.

Plot Size: 2 rows (30") x 33' Planted

2 rows x 30' Harvested

Planted: December 12, 1961

Harvested: August 16, 1962

Above results extracted from test with 16 varieties.

CTR VARIETY TEST

1962

Staten Island

Coop: M & T Inc.

Variety	Source	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	No. Beets 100' Row
1970H2	1 x 3 x SW ₄ n	6673	23.562	14.16	94.73	121
1968H2	1 x 3 x SW ₄ n	6269	23.166	13.53	94.13	126
1967H2	1 x 3 x SW ₄ n	6214	22.797	13.63	94.18	121
1962H2	1 x 5 x SW ₄ n	5849	20.830	14.04	94.52	130
1954-6H2	1 x 5 x SW ₄ n	5767	21.630	13.33	94.83	119
1963H2	1 x 5 x SW ₄ n	5702	21.339	13.36	94.56	126
1963H1	(515H0 x 569) x SW ₄ n	5688	21.240	13.39	93.89	121
USH4	L0336	5407	19.505	13.06	94.99	123
USH6	(NB1MS x NB5) x C663	5328	20.107	13.25	94.93	115
US75	L0255	4753	17.735	13.40	93.82	131
Gen Mean		5317	20.158	13.40	94.56	126
SE mean		2634	.704	.19	.28	
LSD (5%)		518	1.963	.53	.78	
SE mean/Gen Mean (%)		3.49	3.49	1.43	.30	

VARIANCE TABLE

Variation Due To	DF	Tons Beets	Mean Squares % Sucrose =	% T.J.P.
Replication	8	358.196	1.913	4.548
Variety	29	30.974	.913	4.049
Error	232	4.459	.329	.712
Total	269			
Calc. F.		6.95**	2.77**	5.69**

**Exceeds 1% point 1.79

A/ Short Cut Formula

Design: 5 x 6 Rectangular Lattice Analyzed as R.B.

Plot Size: 2 rows (20") x 50'

Planted: 5-15-62

Harvested: 11-24-62

Variety Test

1962

Gerber, California

Coop: Dean Glatz

Variety	Source	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	No. Beets 100' Row
184H3	(NB1MS x NB3) x 984	10343	35.372	14.62	94.79	173
US44	L0336	9720	33.494	14.51	93.91	187
US75	L0255	8806	32.091	13.72	93.44	192
Gen. Mean		9240	32.737	14.12	93.71	178
SEmean		2384/	.739	.18	.36	
LSD (5%)		663	2.056	.49	1.00	
SEmean/Gen. Mean (%)		2.58	2.26	1.24	3.83	

VARIANCE TABLE

Variation Due To	DF	Mean Squares		
		Tons Beets	% Sucrose	% T.J.P.
Replication	8	393.434	68.406	75.583
Variety	35	42.758	.551	2.583
Error	280	4.913	.277	1.160
Total	323			
Calc. F.		8.70**	1.99**	2.23**

**Exceeds 1% Level 1.79

A/Short Cut Formula

Design: 6 x 6 Triple Lattice

Plot Size: 2 rows (34") x 53' Planted

2 rows x 50' Harvested

Planted: April 24, 1962

Harvested: November 7, 1962

Above results extracted from test with 36 varieties.

Variety Test

1962

Chico, Calif.

CTR - Soring Plant

Coop: Chico State Fndn. Farm

Variety	Source	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	No. Beets 100' Row
USH2	(NB1MS x NB3) x C663	4557	19.715	11.54	92.50	130
163H6	(515H0 x 562) x C663	4401	19.154	11.49	93.25	137
USH4	L0336	4319	18.551	11.64	92.74	139
US75	L0255	3844	17.284	11.12	92.27	121
USH6	(NB1MS x NB5) x C663	3414	17.652	9.67	92.87	129
Gen Mean		4046	18.259	11.02	92.64	131
SEmean		294A/	1.165	.38	.48	
LSD (5%)		819	3.241	1.06	NS	
SEm/Gen. Mean (%)		7.27	6.38	3.46	.51	

Variance Table

Variation Due To	DF	Mean Squares		
		Tons Beets	% Sucrose	% T.J.P.
Replication	8	108.841	.63	10.30
Variety	35	61.108	10.07	2.75
Error	280	12.216	1.31	2.03
Total	323			
Calc. F.		5.00**	7.70**	NS

NS-Non Significant

**EXCEEDS 1% Level 1.79

A/Short Cut Formula

Design: 6 x 6 Triple Lattice

Plot Size: 2 rows (30") x 53' Planted

2 rows x 50' Harvested

Planted: April 11, 1962

Harvested: October 30, 1962

Above results extracted from a test of 36 varieties.

TRIPLOID VARIETY TEST

1962

Hamilton City, Calif.

Coop: Chico Fndn. Farm

Variety	Source	Gross Sugar	Tons Per Acre	% Sucrose	% T.J.P.	No. Beets 100' Row
1963H2	(NB1MS x NB5) x SWLn	7119	29.964	11.88	90.2	131
1961H2	(NB1MS x NB5) x SWLn	6960	29.071	11.97	88.9	136
USH2	063H1	6824	29.463	11.58	91.1	137
1963H1	(515HO x 569) x SWLn	6558	27.031	12.13	90.3	121
1954-6H2	(NB1MS x NB5) x Elln. Ln	6197	27.645	11.75	90.3	128
USH6	(NB1MS x NB5) x 663	6313	26.911	11.73	91.1	125
1967H2	(NB1MS x NB3) x SWLn	6310	26.965	11.70	91.6	129
1962H2	(NB1MS x NB5) x SWLn	6139	25.473	12.05	90.3	131
1970H2	(NB1MS x NB3) x SWLn	6002	24.965	12.02	91.2	95
1968H2	(NB1MS x NB3) x SWLn	5537	22.381	12.37	88.2	111
Gen Mean		7143	30.252	11.81	90.7	119
SE mean		4824	1.777	.39	.70	
LSD (5%)		1345	4.954	1.09	1.96	
SE mean/Gen. Mean		6.75				

VARIANCE TABLE

VARIATION DUE TO	DF	MEAN SQUARES		
		TONS BEETS	% SUCROSE	% T.J.P.
Replication	5	29.7923	2.280	5.778
Variety	41	111.6622	1.429	6.750
Error	205	18.9412	.920	2.956
Total	251			
Calc. F.		5.90**	1.55*	2.23**

**Exceeds 1% point 1.69

* Exceeds 5% point 1.45

A/Short Cut Formula

Design: 6 x 7 Rectangular Lattice

Plot Size: 1 row (28") x 28' Planted

1 row x 23' Harvested

Planted: April 11, 1962

Harvested: October 30, 1962

DEVELOPMENT OF TRIPLOID AND TETRAPLOID SUGARBEETS

B. L. Hammond

Seed increases of the tetraploid derivative of the multigerm top-cross parent, 663, have been made. As pollen parent, this tetraploid along with the male-sterile monogerm diploids, MS of 515 x 569, and MS of 562 x 569, and the male-sterile multigerm diploid, MS of NBl x NB3, were isolated for production of triploid seed. These triploid hybrids were evaluated in 1962 and 1963 in USDA and cooperative sugar company variety tests. The results of these tests will be found in the section of these reports dealing with the performance of triploids.

Composite seed increases were made in 1962 and in 1963 of a number of T8-line single-plant tetraploid selections. The T8 line was a group of tetraploid plants produced from S_6 (US22/3 x NBl). The composite increase has been assigned the number 3423.

Seed increases of the multigerm tetraploid inbred 0539 (NB7) also were made in 1962 and in 1963.

In the early part of this program, work was begun on developing a male-sterile monogerm tetraploid line from type O monogerm inbred, 0562, and its male-sterile equivalent, 9561H2, for use with diploid pollinators. The tetraploid line proved to have retained the excellent male-sterility shown in the diploid line. Seed increases have been made, and cytological and breeding work involving other inbred lines is under way.

The diploid monogerm lines SL0156 (MSmm x CT5mm) and SL0267 (SLC129mmaa x CT5mmAa) developed by Dr. Owen were made tetraploid. A seed increase of these lines was made in isolation during the summer of 1963.

Seventy-four colchicine-treated seedlings of the monogerm inbred 0546-36 were selected in July 1961 on the basis of cytological examination and thermally induced for 4 months, after which they were interpollinated. C_1 seed was harvested in April 1962, and a portion of it was planted in the summer. Seventy-four tetraploid seedlings with green hypocotyls and 60 with red hypocotyls were placed under thermal induction in October for seed increases. Plants were removed from thermal induction in April 1963 and interpollinated. Seed was collected in September. Only 3.5 gms. of seed were harvested from plants with green hypocotyls and 18 gms. from plants with red hypocotyls, indicating very low fertility this time of year.

Pregerminated seed of the monogerm inbred 0546-48 was colchicine-treated in June 1961. After cytological examinations, 72 were selected for thermal induction in October 1961. These were removed in March 1961 and interpollinated. Thirty-two grams of C_1 seed were harvested in July 1962. Some of this was planted in October for selection of tetraploid plants for seed increase. In December 1962, the seedlings were placed in bands. Of the 131 C_1 seedlings examined, all were tetraploid. These were placed under thermal induction in March 1963 and transferred to isolators in July. Five-hundred twenty gms. of seed were harvested in December.

Fifty-seven colchicine-treated seedlings of the monogerm inbred 0546-22 planted in July 1961 were selected and placed in the coldroom for thermal induction in November 1961. These were removed in April 1962 and interpollinated. Only $4\frac{1}{2}$ gms. of C_1 seed were obtained. Work on this selection was discontinued in favor of the more highly curly-top-resistant selection 1546-22 described below.

One-hundred thirty-eight colchicine-treated seedlings of the monogerm inbred 1546-22 were transplanted to pots in October 1961. Forty-nine of these were selected for thermal induction in December 1961 and removed in May 1962 for interpollination. Only 17 gms. of C_1 seed were obtained, indicating a fairly high degree of infertility. A portion of this seed was planted in October 1962 for the selection of tetraploids for seed increase and for crossing with the male-sterile line, 562HO-T. (This cross is described elsewhere in the report.) In December 1962, the seedlings were transplanted to bands. These were placed under thermal induction in April 1963 and transferred to isolators in August. Two-hundred sixty-six gms. of seed from 1546-22T were harvested in December.

In September 1962, pregerminated seed of type 0 monogerm inbred 1672 was colchicine-treated. The seedlings were transplanted to pots in October 1961. Fifty-four plants including 15 with green hypocotyls were selected for thermal induction in February 1962. These were removed from the coldroom in July 1962 and interpollinated. The C_1 seed was harvested in November 1962. Only 1.8 gms. of seed were obtained from the plants with green hypocotyls. 14.5 gms. were obtained from plants with red hypocotyls. Seed increases will be made from both classes. This selection originated from a backcross to the NBl multigerm inbred.

Pregerminated seed of the type 0 monogerm 1561-16-7C1 was treated with colchicine in January 1962. The seedlings were potted in March and, on the basis of cytological observations, 42 plants were placed under thermal induction in May 1962. These were removed in October and interpollinated. In March 1963, 18 gms. of C_1 seed were harvested and a portion planted for selection of tetraploid plants for a seed increase and for crossing to the male-sterile line, 562HO-T. This inbred was recently found highly resistant to curly top.

Sixty-six colchicine-treated seedlings of the type 0 multigerm 871 were selected for thermal induction in July 1961. These were removed from the coldroom in November 1961 and interpollinated after being examined cytologically. Fourteen of these having green hypocotyls were pollinated separately. C_1 seed was obtained from each class in June 1962. In August, seed from both classes was planted in Oregon to obtain stecklings for seed increase at Salinas. In March 1963, 23 stecklings having green hypocotyls and 72 having red hypocotyls were brought from Oregon and stored in the coldroom until July when they were placed in isolators. Two-hundred thirty-six gms. of seed from plants with green hypocotyls and 286 gms. from plants with red hypocotyls were harvested in November.

Pregerminated seed of the type 0 multigerm F57-85 and its male-sterile equivalent, F57-85H0, was colchicine-treated in late fall of 1961. Sixty-five plants of F57-85 and 67 plants of F57-85H0 were selected for thermal induction in April 1962. These were removed in September. Crosses between F57-85H0 C_0 and F57-85 C_0 as well as F57-85 C_0 sib crosses were made. C_1 seed was planted in January 1963. One-hundred twenty-five tetraploid plants of each kind were placed under thermal induction in May 1963. Sixty plants of each were removed in October for seed increase. The remainder will be removed later.

In last year's report, it was noted that 9 plants of F57-85 C_0 and 5 plants of F57-85H0 C_0 had bolted prior to thermal induction. Bolting in the greenhouse of highly non-bolting commercial varieties not thermally induced apparently had not been observed. These plants were crossed in the manner described above for the non-bolting ones. The small amount of C_1 seed obtained was planted in August 1962. From the cross, F57-85H0 C_0 X F57-85 C_0 , 40 seedlings were obtained, all of which were tetraploid. Twenty-three seedlings were obtained from F57-85 C_0 , also tetraploid. This material was placed under thermal induction in December 1962 for seed increases and removed in August 1963. During thermal induction, most of the plants died from disease. From the remaining few plants, 27 seeds were obtained from (F57-85H0 X F57-85)T and approximately 100 from F57-85T. Seed increases will be used later for comparison with tetraploids from non-bolting plants with respect to degree of bolting under field conditions.

Pregerminated seed of the type 0 monogerm inbred F61-515 was colchicine-treated in June 1962. Of the 52 plants obtained, 31 were selected on the basis of cytological examination for thermal induction in October. They were removed from the coldroom in April 1963 and interpollinated. Thirty-four grams of seed were harvested in September 1963. This selection was highly sensitive to the colchicine treatments. Since nearly 100 percent of these plants have red hypocotyls, this inbred should be of considerable value in outcrossing studies.

Forty-eight colchicine-treated seedlings of the vigorous multigerm inbred 1547 (from NB5) planted in July 1962 were placed in the coldroom for thermal induction in October. Twenty-eight of these had green

hypocotyls, and 20 red hypocotyls. The latter will be used in outcross studies. All were removed from the coldroom in April 1963, and each class was interpollinated separately. Seed was harvested in September; 15 gms. from plants with green hypocotyls and 26 gms. from plants with red hypocotyls. For the purpose of securing additional plants with red hypocotyls, a second planting of colchicine-treated seedlings of this material was made. Fifty-eight plants having red hypocotyls were placed under thermal induction in March 1963 and removed in July 1963 for interpollination and seed increase.

In July 1962, pregerminated seed of multigerm 586 was colchicine-treated. On the basis of cytological observations, 62 plants were selected for thermal induction and placed in the coldroom in December. They were removed in July 1963 and interpollinated. Twenty plants had green hypocotyls and 42 red hypocotyls. This selection is an open-pollinated multigerm. It is high in sucrose percentage, but low in root yield. Crosses will be made with 663T and with 871T in an attempt to develop a tetraploid top-cross parent with good tonnage and sucrose percentage.

Colchicine-treated seedlings of the multigerm inbred F59-509 (NB3) planted in August 1962 were transplanted to pots in November. In January 1963, 38 selected C_0 plants were placed under thermal induction and removed in July for interpollination. All plants have red hypocotyls, a character which will facilitate studies in outcrossing involving tetraploids derived from self-fertile diploid inbreds.

Pregerminated seed of Selection F58-554 (NB4) was treated with colchicine and planted in late October. They were transplanted to pots in December 1962. Seventy-four selected C_0 plants were placed in the coldroom for thermal induction in March 1963 and removed in August for interpollination. This selection is a small-seeded, multigerm inbred. All plants have green hypocotyls.

In November 1962, pregerminated seed of selection 2559-1 was colchicine-treated. Seedlings were potted in January 1963. Sixty-seven C_0 plants selected on the basis of cytological examination were placed under thermal induction in May 1963 and removed in August for interpollination. After 5 weeks with no evidence of bolting, these plants were returned to the coldroom for further thermal induction. This selection is a multigerm inbred similar to NBl. Nearly 100 percent of the seedlings had red hypocotyls, a character which will facilitate studies in outcrossing.

Pregerminated seed of selection 164, a bolting resistant selection from 663, was colchicine-treated in June 1963. Seventy-eight selected C_0 plants (68 with red hypocotyls and 10 with green hypocotyls) were placed under thermal induction in September.

One-hundred fifty-five colchicine-treated seedlings of selection 330 were transplanted to pots in September 1963. Seventy of these

(16 with green hypocotyls and 54 with red hypocotyls) were placed in the coldroom for thermal induction in December 1963. This is a selection from the self-sterile, multigerm, US 75, and is yellows resistant.

Colchicine-treated seedlings of selection 952 were planted in July 1963 and transplanted to pots in September. Desirable C₀ plants are now being selected for thermal induction. This is a self-sterile, type O selection from US 15.

663T X 0539T (C3425).--A seed increase of this cross was made in Oregon in 1963. Performance tests are now in progress.

871T X 0539T.--In August 1962, 871C₁ seed was planted in the Salinas greenhouse for the purpose of selecting tetraploid seedlings for crossing with 0539T (tetraploid of 0539 already produced) planted at the same time. Of the 150 871C₁-seedlings potted, all were tetraploid. These together with 125 tetraploid seedlings of 0539 were placed under thermal induction in November 1962. They were removed in May 1963 and crossed. Thirty-seven grams of seed from the self-sterile parent, 871T, were collected in September. This cross will be evaluated in field tests.

562HO-T X 1546-22T.--Earlier in the program, a male-sterile, monogerm-tetraploid line was developed from the type O monogerm, 0562, and its male-sterile equivalent, 9561H2. This line was crossed with the highly curly-top-resistant selection 1542-22T, a monogerm inbred, type O. Seed of both selections was planted in October 1962, transplanted to bands in December, and placed under thermal induction in April 1963. Seedlings of these selections were placed in isolators in August. An additional isolation of 1546-22T was also made for seed increase. All seed was harvested in December 1963.

562HO-T X 563T.--The male-sterile, monogerm inbred line, 562HO-T, is also being crossed with the tetraploid selection of 1561-16-7C₁ (563T). Seedlings of both lines were placed in the coldroom for thermal induction in July 1963. The diploid form of the latter selection has been made available through the foundation as C2563. It is a type O monogerm and highly resistant to curly top.

2423T (T8 Increase) X 1547T.--In December 1963, seed of 2423T, together with seed of the multigerm inbred, 1547T, was planted for the purpose of making crosses between these two selections. 2423T is a composite seed increase of a number of T8-line single-plant tetraploid selections derived from S₆(US22/3 X NBl). The gene for red hypocotyl in 1547T will be used in selecting crosses.

2539T X 1547T.--Also in December 1963, tetraploid seed of the multigerm inbred 2539 (from NB7), together with seed of another tetraploid, multigerm inbred, 1547T, was planted for the purpose of crossing these two inbreds. Selection 2539T has green hypocotyls. Being also self-fertile, only the red-hypocotyl plants of 1547T will be used for selecting actual crosses.

Studies are in progress to determine the effect of polyploidy on the bolting of annual beets. For this purpose, 2589C1 and 2541 were selected. Seed of 2589C1 was colchicine-treated in June 1962. The 25 surviving plants were potted. Upon bolting, the 5 plants showing predominantly tetraploid tissue at the tips of inflorescences were selfed. Forty-three C_1 seedlings were obtained from seeds collected in January 1963. Of these, 39 were tetraploid, 2 were triploid, and 1 was a haploid having 9 chromosomes (Figure 1). Seed of 2541 was colchicine-treated in January 1963. Eleven gms. of 2589C1-T seed and 11 gms. of 2541 C_1 seed were collected in September.

The haploid mentioned above is being increased by means of vegetative propagation. Colchicine will be used in an attempt to double the number of chromosomes in order to obtain fertility and produce a homozygous population.

The C_1 seedlings of selection 0546-36 described earlier in this report have revealed a rather interesting situation. Upon separating the diploid seedlings from the tetraploid during the summer of 1962, it was noted that the diploid seedlings had been heavily infested with spider mites, whereas the tetraploids showed no signs of having been infested (Figure 2). Comparisons of tetraploids, triploids, and diploids of this and other selections or varieties made tetraploid will be made with respect to resistance to mites. It is commonly known that spider mites are troublesome on sugarbeets in the Imperial Valley.



Figure 1. A vigorous, haploid sugarbeet with 9 chromosomes, found among C_1 seedlings of 2589C1. Leaves are relatively narrower and more tapered than those of diploid beets. Plant flowered profusely during the summer months of 1963. Flowers were small with anthers devoid of pollen.



Figure 2. C_1 diploid and tetraploid seedlings of inbred 0546-36 after separation. Diploid seedlings at right show effects of having been heavily infested with spider mites. Tetraploids on left show no signs of infestation.

STUDIES ON THE GERMINATION OF MONOGERM SUGARBEET VARIETIES
AND INBREDS DEVELOPED AT SALINAS, CALIFORNIA

I. O. Skoyen

The tests reported here were made as a result of low germination found to exist in the 1962 Oregon seed increases of USDA originated hybrid monogerm varieties.

Random seed samples of each variety tested were used in crack tests to determine apparent seed-ball fill and for the germination tests. Seed treatments, following a 4-hour presoaking in running tap water, consisted of removing the glandular disc before planting, removing the seed from the cork, and planting the whole or intact seed ball. Fifty seed balls were used for each test, with a few exceptions in which 25 seed balls were used. Seed was placed between moistened blotters in petri dishes or planted in flats of sand. Tests were also made with whole unsoaked seed in the sand cultures. The tests in sand were made in the greenhouse and the blotter tests in the laboratory.

The blotter tests in the laboratory were made at room temperatures. These ranged from nighttime lows of 62-68° F to daytime highs of 68-74° F. The greenhouse temperatures ranged from nighttime lows of 46-68° F to daytime highs of 78-90° F.

An additional experiment was conducted in which solutions of a household detergent, at various concentrations, were used as a seed soak. These were used in conjunction with various water soak treatments. The hybrid variety 2539H8 was used in these tests.

No fungicide seed treatments were used in the germination tests.

The whole seed germinated on blotters was counted as germinated when sprouts were at least one-fourth inch long. Seed with the glandular discs removed was considered sprouted when any evidence of growth was noted because of the possibility of seed injury when the cap was removed which would result in abnormal growth. In the sand cultures counts were made of emerged seedlings.

The descriptions of the monogerm varieties and inbreds tested are listed below.

Seed produced in 1962

<u>Variety No.</u>	<u>Description</u>
263TH3 (3N)	(515HO x 569) x 663 Tetraploid
263TH4 (3N)	(562HO x 569) x 663 Tetraploid
263H6	(515HO x 562) x 663
263H8	(569HO x 562) x 663
2539H1	(515HO x 569) x NB7
2539H6	(515HO x 562) x NB7
2539H8	(569HO x 562) x NB7
F62-546	Inbred 546-22
F62-546HO	(546-22HO x 546)
F62-546H1	(562HO x 546)
F62-569H3	(562HO x 569)

Seed produced in 1961

163H5 (515HO x 569) x 663
 Lot 1370

Results showed that, with few exceptions, removing the glandular discs from the seed balls substantially increased the germination percentages for both blotter and sand tests (Table 1). Percentages shown are based on approximately 14-day test periods. Repeated tests on seed with the discs removed showed uniform germination regardless of blotter or sand tests, but results on whole seed were generally just the opposite. Periodic counts of germination, continued up to 32 days after planting, showed whole seed germinated as much as 54 percent below that of seed with discs removed. Results also indicated no significant increase in germination for seed completely removed from the cork over seed balls with only the glandular discs removed.

Removing the glandular discs and examining unsprouted seed balls after approximately three weeks' testing indicated that frequently seeds were still firm and appeared capable of germination. Moisture appeared to have penetrated the cork but not the seed coat of the firm seeds. By pricking the seed coat and breaking away small particles of the seed, the consistency was found to be dry and mealy. Seeds showing moisture penetration through the seed coat were generally soft and deteriorated and often appeared to be only partially developed. Continuing germination tests on the good seed for several days resulted in increasing total germination percentages by 4 to 20 percent.

Table 1.--Germination of seed of monogerm sugarbeet varieties and inbreds following various seed treatments.

Variety No.	Test No. ^{1/}	Germination			Seed-ball Fill Percent
		Whole Seed	Discs Removed	Bare Seed	
		Percent	Percent	Percent	
263TH3 (3N)	1	21	59	73	76
	2	18	69		
	3	20			
263TH4 (3N)	1	24	80		81
	2	32	76		
	3	44			
263H6	1	53	78	76	84
	1	32	75		
	2	16	72		
	3	48			
263H8	1	64	80		77
	1	38	88		
	2	24	88		
	3	50			
2539H6	1	48	81	76	88
	2	44	79		
	3	48			
2539H8	1	54	74		88
	1	38	72		
	2	44	72		
	3	48			
F62-546	1	61	64		82
	1	48	64		
	2	18	64		
	3	34			
F62-546HO	1	38	84	76	83
	1	24	68		
	2	10	64		
	3	20			
F62-546HL	1	24	85		83
	2	20	74		
	3	36			
F62-569H3	1	62	88	78	88
	1	42	74		
	2	58	80		
	3	38			
2539HL Unprocessed	1	75	91	92	92
	3	66			
	1	77	90		
Processed	3	63			
163H5 Lot 1370					
	Unprocessed				
	1	74	86	88	
	3	59			
	Processed				
	1	97	98		97
	3	74			

^{1/} Test numbers refer to:

1. Seed soaked 4 hours and placed between blotters in petri dishes.
2. Seed soaked 4 hours and planted in flats of sand.
3. Unsoaked seed planted in flats of sand.

Comparisons were made on the germination of processed and unprocessed seed of two hybrids, 2539H1 and 163H5 (Lot No. 1370). Results of tests on 2539H1 showed no difference in germination between unprocessed and processed seed (Table 1). The higher germination shown for seed with the discs removed over whole seed, after 14 days, was reduced to 6 percent for both sand and blotter tests after 21 days. As the results show, processed seed of 163H5 germinated as much as 23 percent higher than unprocessed seed after 14 days. After 21 days, in the blotter tests, processed seed with discs removed germinated about 12 percent higher than unprocessed seed with discs removed. Whole processed seed, in the sand tests, germinated 91 percent in 23 days and unprocessed whole seed 85 percent in 22 days.

The purpose of the experiments, in which detergent solutions were used in soaking treatments on the seed balls, was to determine if addition of a wetting agent to water was effective in increasing moisture penetration into the seed ball. Results of the experiments indicated little if any increased germination response with the use of detergents (Table 2).

CONCLUSIONS

The results reported show that the potential germination of most of the hybrid varieties tested may be substantially higher than that obtained in tests on whole seed. Similar trends were shown for the inbreds and the F_1 hybrids tested. The increase in germination obtained by removing the discs on seed after three weeks' testing is an indication that part of the problem is failure of moisture penetration through the seed coat. It appears that removing the glandular disc from the seed ball ruptures the seed coat allowing moisture penetration. The improvement in germination often obtained by processing sugarbeet seed is probably due not only to removal of light and empty or only partially developed seed balls but also is influenced by the effects of abrasion or polishing on good seed. The tests on processed and unprocessed seed from lots with good germination showed that differences may be more apparent than real when 14-day and 21-day germination test periods are compared.

Table 2.--Germination of seed of the monogerm hybrid 2539H8 following various soak treatments with water and with detergent solutions.

Seed Treatment	Test Period (Days)	Percent Germination											
		1/2 hour water plus				2 hours water plus				4 hours water plus			
		dry seed planted in Sand (Percent)	2 hours 0.05% detergent on Blotters (Percent)	2 hours 0.05% detergent in Sand (Percent)	2 hours 0.05% detergent on Blotters (Percent)	1/2 hour 0.05% detergent on Blotters (Percent)	1/2 hour 0.05% detergent in Sand (Percent)	1/2 hour 0.1% detergent on Blotters (Percent)	1/2 hour 0.1% detergent on Blotters (Percent)	1/2 hour 0.3% detergent on Blotters (Percent)	1/2 hour 0.3% detergent on Blotters (Percent)	1/2 hour 0.3% detergent on Blotters (Percent)	1/2 hour 0.3% detergent on Blotters (Percent)
Whole Seed	3		12		20	36		38		24	34	26	24
	5	24	52	4	41	52	16	50		43	62	42	40
	7	40	56	28	45	52	32	50		43	66	42	44
	9	48	64	32	47	56	40	50		43	66	47	48
	11				47			50		43	66	47	48
	13				49			50		48	66	47	52
Glandular Discs Removed	3		40		62	44		54		60	74	57	64
	5	60	76	36	76	88	67	67		73	82	67	72
	7	80	80	44	76	88	79	67		77	82	70	76
	9	80	80	44	76	88	79	67		77	82	70	80
	11				76			67		77	82	70	80
	13				76			67		77	82	70	80

P A R T III

DEVELOPMENT AND EVALUATION OF INBRED LINES
AND HYBRID VARIETIES OF SUGARBEETS

with emphasis on

Curly Top Resistance,
Monogermness, and High Quality

- - - - -

STUDIES ON GENETICS OF MALE STERILITY
IN THE SUGARBEET

- - - - -

GREENHOUSE TECHNIQUES
TO EVALUATE BREEDING MATERIAL FOR
RESISTANCE TO CURLY TOP AND VIRUS YELLOWS

- - - - -

PHOTOSYNTHESIS AND RESPIRATION

Foundation Projects 17, 21, and 27

A. M. Murphy
J. C. Theurer
G. K. Ryser

C. L. Schneider

C. H. Smith
Myron Stout
E. H. Ottley

Cooperation:

Utah Agricultural Experiment Station

Preliminary Studies of Asexual Transfer of Cytoplasmic Male Sterility in Sugarbeets.

J. C. Theurer and E. H. Ottley

The transfer of cytoplasmic male sterility from one line to another by asexual means would be a valuable technique for the plant breeder. This is because it would be a more rapid conversion method than the conventional backcross and would not alter the genotype of a line which had been previously selected for other desirable characteristics.

In 1956 Frankel (3)^{1/} reported that cyto-sterility was transferred from one line of *Petunia* to another by the simple technique of grafting. Subsequent studies with *Petunia* (2, 4) have given further support to this possibility. Attempts to transfer cytoplasmic male sterility by grafting have failed in studies with corn (6) and tobacco (7). Thus, the transfer phenomenon may be a peculiarity of the *Petunia*.

The objective of this study was to evaluate the possibility that cytoplasmic male sterility in sugarbeets could be transferred by grafting.

Materials and Methods

A description of the sugarbeet lines used for grafting is given in Table 1.

Grafting procedures for annuals included: Coe's seedling method (1), Johnson's seedling-seedstalk method (5), and cleft grafting of succulent seedstalks. Attempts were made to graft male-sterile scions onto fertile stocks, fertile scions onto male-sterile stocks, male-sterile scions onto male-sterile stocks, and fertile scions onto fertile stocks. The latter two types of grafts were made to observe whether grafting per se has any effect upon the degree of fertility. Stecklings and mother beets were grafted using Stout's plug method (8).

All fertile scions were selfed and male-sterile scions on fertile seedstalks were sib pollinated. To date the G_0 ^{2/} and part of the G_1 generations have been carefully checked for phenotypic changes in pollen production. The degree of fertility for each plant in each generation was determined by microscopic examination of stained pollen grains at anthesis of the first flowers on the terminal branch of the seedstalk.

^{1/} Numbers in brackets refer to literature cited.

^{2/} G_0 refers to the scion, G_1 to the first self or sib generation.

Table 1. Sugarbeet lines used for grafting studies

Current Number	Description	
<hr/>		
	<u>Annuals</u>	
14460	SLC 03	BBMMrr
04460H0	SLC 03 CMS	BBMMrr
	<u>Biennials</u>	
Stecklings:		
2104-1	SLC 129 CMS subline	bbmmrr
9502	SLC 129	bbmmrr
Mother Beets:		
0223	CT 5	bbmmrr
1114	(SLC 127 X 128) X CT5	bbmmrr
1122	SLC 129 X CT 5	bbmmrr
1124	(SLC 127 X 129) X 129	bbmmrr

Results and Discussion

Several grafts were made by each seedling graft method, however, only a small percentage of them was successful (Table 2). A minimum of 50 grafts was made, using Coe's method in which very young seedlings are inserted into the crown of seedlings used as stocks. This method was the only one which resulted in complete failure. This, no doubt, was due to two factors, dislodging of the scion by the growing tip of the stock before union occurred, and the relatively poor facilities available for maintaining high humidity. The cleft grafting method was successful when very young succulent seedstalks of comparable size were used, although this type of graft was quite susceptible to injury and breakage of the grafted seedstalk. The most successful seedling grafts were made using a modification of Johnson's method wherein grafting wax rather than string was used in joining the seedling scion to the seedstalk. Over 70% of the plug grafts was successful. Another 10% made successful union between scion and stock but later died, presumably due to a bacterial blight.^{3/}

Some of the mother beets in the grafting study were infected with curly-top virus. Of interest was the observation that some of the scions grafted onto these roots showed typical curly-top symptoms indicating that the virus was transmitted across the graft union.

The fertility of the annual pollinator line ranged from 55 to 90% with an average of 80% stainable pollen (Table 3). By comparison fertile scions, regardless of the stock they were grafted on, were also about 80% fertile. Repeated examination of grafted plants failed to reveal any phenotypic alteration in the fertility of the scions. All branches of a plant and all flowers on the different branches had yellow anthers.

All male-sterile scions of the G_0 generation remained completely male sterile regardless of the fertility of the stock they were grafted to.

The pollen fertility of lines in the G_1 generation from self-pollinated G_0 scions is given in Table 4. The various lines ranged from 10% to 90% with an average of 52% stainable pollen. In comparison with the annual pollinator (Table 3) the G_1 lines appear to be considerably lower in fertility. However, the fertility readings of pollinator grafted onto male sterile were similar to those of pollinator grafted onto pollinator. Thus, the decrease in fertility was probably due to

^{3/} Dr. C. L. Schneider observed that symptoms were similar to those caused by Pseudomonas aptata which he observed on beets at Beltsville in 1959.

environmental effects or to a physiological disturbance conditioned by grafting per se. Phenotypic variation in sterility between flowers or branches of the seedstalk of a plant was not observed in this generation either.

Representative lines of the G_1 generation of plug grafts are presently being grown in the greenhouse, but data concerning sterility will not be available until the spring of 1964.

Table 2. Number of grafts made and percent successful union by method.

Method	Scion	Stock	Number made	Number successful	Percent successful
Seedling insert (Coe)	MS	F	25	0	0
	F	MS	25	0	0
Seedling on bolter (Johnson)	MS	MS	75	11	15
	MS	F	82	7	9
	F	MS	135	17	13
	F	F	30	3	10
Cleft seedstalk grafts	F	F	8	5	63
	F	MS	25	2	.08
	MS	F	20	2	10
Plug grafts			350	251	72

Table 3. Fertility of pollinator scions grafted on pollinator and male-sterile stocks, and seed obtained from the selfed scions.

Plant Number	Graft segment		G ₁ generation	
	Stock % fertile ^{1/}	Scion % fertile ^{1/}	Current Number	Seed (No. seedballs)
1	70	90	G-3501	5
2	55	65	--	0 ^{2/}
3	90	90	G-3502	15
4	90	90	G-3503	22
5	85	80	G-3504	90
6	90	80	G-3505	48
9	MS	90	G-3281A	96
10	MS	90	G-3291	19
11	MS	90	G-3289	105
12	MS	90	G-3290	88
13	MS	50	G-3285	235
14	MS	75	G-3286	28
15	MS	75	G-3292	133
16	MS	80	G-3287	31
17	MS	90	G-3288	66
18	MS	60	G-3293	68
19	MS	60	G-3282	70
20	MS	80	G-3283	166
21	MS	90	G-3284	198

^{1/} Percent fertility based on microscopic determination of aceto-carmin stained pollen.

^{2/} Seedstalk accidentally broken shortly after anthesis.

Table 4. Pollen fertility in the G_1 generation from selfed G_0 scions.

Plant Number	Current Number	No. G_1 generation Plants	Pollen fertility ^{1/}	
			Range	Average
1	G-3501	0	-----	-----
2	-----	0	-----	-----
3	G-3502	18	30-70	55
5	G-3503	3	50-70	57
6	G-3505	72	10-80	44
9	G-3281A	124	10-80	50
10	G-3291	22	30-95	53
11	G-3289	56	10-80	47
12	G-3290	31	10-90	59
13	G-3285	116	20-80	54
14	G-3286	10	20-90	48
15	G-3292	44	10-90	50
16	G-3287	32	20-90	60
17	G-3288	57	10-80	47
18	G-3293	15	25-70	52
19	G-3282	39	10-90	53
20	G-3283	127	10-80	50
21	G-3284	65	10-85	53

^{1/} Percent fertility based on microscopic determination of acetocarmine stained pollen.

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A Preliminary Study of Environmental Instability of Male Sterility in Sugarbeets

J. C. Theurer, Myron Stout, G. K. Ryser

Several research workers have noted that the expression of male sterility is greatly influenced by the environment in which the plants are grown. This variation has been observed not only within a given line, but even among branches on the same plant and flowers on the same branch. In some cases male-sterile plants that have been bagged produced a small amount of pollen, while unbagged sister plants remained male sterile. An apparent aging factor has also been reported wherein older plants, previously scored as male steriles, began producing a limited amount of viable pollen.

Relatively little research has been conducted regarding the climatological, nutritional or physiological factors influencing male sterility; however, evidence has been found to suggest that this instability is under genetic control.

A pilot study was conducted this year to observe differences in male-sterility expression due to temperature, light intensity, nutrition, and bagging.

Materials and methods

Stecklings of 15 male-sterile hybrids were photothermally induced, planted in 7-inch clay pots, and placed in a single section of the greenhouse. They were grown under artificial light until seedstalks of the earliest bolting plants were about a foot high. On April 2, 1963, the plants of each line were separated into 7 lots. To make up a factorial experiment involving 3 temperatures and 2 light intensities as shown in table 1, 2 lots, consisting of 12 plants of each line, were placed in bay 3 of the greenhouse, 2 in bay 5, and 2 in a cold chamber. One-half of the plants of each line within each of the 6 environments were randomly bagged with a Snowfibre paper bag when plants were in the early bud stage of development. The seventh lot, consisting of 4 plants of each line, was further subdivided for nutritional studies under the environmental conditions listed in table 1. Minor elements were applied as foliar sprays to the two small sublots at weekly intervals prior to flowering.

At anthesis the degree of fertility was determined by microscopic examination of aceto-carmin-stained pollen from 3-4 mature flowers

Table 1 - Average light intensity and temperature exposures for sugarbeet environment study.

Location	Foot-candles ^{1/}	Average temp. ° F.		
		Max,	Min.	Mean
Bay 3 East	175	71.4	62.1	66.7
Bay 3 West	93			
Nutritional Study ^{2/}	138			
Bay 5 East	169	64.5	52.2	58.4
Bay 5 West	92			
Cold Room East	314	45.0	43.0	44.0
Cold Room West	149			

^{1/} Foot-candles at 2 feet above bench or bed.

^{2/} Minor element spray treatments:

1. 90 ppm $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$ applied weekly April 4 to 29.
2. Iron chelate 167 ppm; $\text{MnSO}_4 \cdot 4\text{H}_2\text{O}$ 75 ppm; H_3BO_3 50 ppm; ZnSO_4 8 ppm; $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$ 4 ppm; COCl_2 1 ppm and $(\text{NH}_4)_2\text{MO}_4$ 3 ppm applied weekly April 4 to 29.

of each plant. The plants in bay 3, bay 5, and those in the nutritional study were resampled every two days for 3 weeks in order to ascertain if any changes in fertility occurred on other branches of the same plant or occurred due to aging of the plant. Since plants in the cold chamber were relatively slow in flowering, they were resampled for fertility at weekly intervals for 11 weeks.

Results and Discussion

The number of pollen-producing plants and the average percent fertility for each line with respect to the various environmental conditions are given in table 2. A few plants produced as high as 70-80% stainable pollen, however, the average percent for the lines ranged from .3 to 26.0%. Pollen-producing plants were observed in 9 of the 15 lines in the high-temperature environment, in 6 lines in the 58° F. unit, and in only 1 line in the cold chamber. Most of the male-sterile plants in the latter environment showed a blasted condition rather than typical male sterility. These results suggest that the higher the temperature the greater the number of plants that will produce pollen. Consequently, screening for O type pollinators should be done at relatively high temperatures if this is a valid conclusion for all varieties. However, this study was extremely limited in scope and additional work is required to substantiate this conclusion. It is noted that two lines (20 and 30) had more partially fertile plants in the environment at 58° F. than at 67° F., and 3 lines (20, 30, and 41) had a greater degree of fertility, on the average, at 58° F. than plants of the same lines flowering at higher temperatures.

Four lines (26, 41, 57, and 66) had more fertile plants and a greater degree of fertility under high light intensity than under low light intensity. This trend was reversed for lines 30, 32, and 38.

Lines 20, 38, 49, and 66 showed greater fertility when bagged, while 5 other lines (26, 30, 32, 41, and 57) gave the opposite conclusion.

Only lines 20, 26, 30, 32, and 38 showed fertile plants when treated with minor elements. The average fertility of these treated lines was greater than that of untreated plants grown in the same greenhouse. However, inasmuch as one or more of the untreated plants exceeded the fertility of the plants sprayed with minor nutrients, this difference, no doubt, was due to chance alone.

Some of the semi-sterile plants observed in this study gave similar percentages of fertility with repeated pollen sampling.

Table 2. Number of pollen-producing plants and average percent fertility of 15 hybrid lines of sugarbeets.

Line No.	Description	Temperature		Light Intensity		Not Bagged		Nutrition											
		58° F.		Low		Bagged		Treatment											
		67° F.	44° F.	High	Low	No. 1	No. 2	No. 1	No. 2										
		No. 1/4/	No. 1/4/	No. 2/4/	No. 2/4/	No. 2/4/	No. 2/4/	No. 2/4/	No. 2/4/										
20	SLC 122 CMS	6	16.3	7	22.7	2	2.6	9	13.8	6	13.8	8	24.5	7	12.9	2	26.0	1	3.0
23	SLC 127 CMS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
25	SLC 129 CMS	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
26	7121 X 86.97	6	12.0	3	8.3	0	0.0	6	4.6	3	4.0	5	2.9	3	4.7	1	15.0	0	0.0
30	SP 557 CMS	1	0.6	6	12.2	0	0.0	2	1.6	5	6.9	3	1.8	4	6.7	0	0.0	1	13.0
32	7121 X 803	9	14.1	3	13.3	0	0.0	6	4.9	6	5.3	6	4.1	6	6.2	1	24.0	1	4.0
38	9142 X 9202	1	1.4	0	0.0	0	0.0	0	0.0	1	0.9	1	0.9	0	0.0	0	0.0	1	5.0
39	9142 X 95.68.3	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
41	9145 X 95.5.5	3	3.3	2	13.3	0	0.0	3	2.1	2	1.0	2	0.7	3	2.4	0	0.0	0	0.0
42	9146 X 95.244.11	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
44	9351 X 9202	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
48	9352 X 9202	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0	0	0.0
49	9142 X 95.501	4	1.6	0	0.0	0	0.0	3	0.5	1	0.6	2	0.8	2	0.2	0	0.0	0	0.0
57	308H0-1 X 9628-321	5	7.0	0	0.0	0	0.0	3	2.8	2	1.8	3	1.3	2	3.4	0	0.0	0	0.0
66	0156 X 0223	3	2.9	1	0.3	0	0.0	3	2.8	1	0.4	1	1.8	3	0.5	0	0.0	0	0.0

1/ Number of plants having stainable pollen with a total of 12 plants for each line.

2/ Number of plants having stainable pollen with a total of 18 plants for each line.

3/ Number of plants having stainable pollen with a total of 2 plants for each line.

4/ Average percent fertility based on the total number of plants.

Others showed considerable variation with some plants increasing and others decreasing in percent of fertile pollen. No consistency was observed wherein all pollen-producing plants of a line showed a similar trend to increase or decrease upon repeated pollen sampling.

Six lines appeared to be environmentally stable since they remained male sterile under all environmental conditions imposed in this study. These lines will provide good parent material for test crosses to be used in conducting more refined studies of the inheritance of environmental instability of male sterility which are now possible with the new growth chambers recently installed at Crops Research Laboratory.

Notes on Clonal Propagation of Sugarbeets

J. C. Theurer, E. H. Ottley, G. K. Ryser

Several procedures were used this past year to clonally propagate various lines of sugarbeets preparatory to experiments concerning environmental influence on cytoplasmic male sterility. In general, cuttings were made of vegetative seedstalks according to Owen's suggestions (1) but, in addition, were treated with rooting compounds and placed in rooting beds of different media.

Cuttings dipped in indole-3-acetic acid or Rootone rooting compound showed little difference from untreated cuttings. Hormone treatment of woody material seemed to help rooting, however, these cuttings seldom developed sufficient roots to carry the plant through to a healthy growing condition when transplanted. Observations showed that young succulent cutting material was far more critical than hormone treatment in obtaining a high degree of success.

The following types of substrate were used for rooting medium: vermiculite, perlite, sand; 50-50 mixture perlite and sand; 50-50 mixture vermiculite and sand. The latter medium was by far the best, giving more roots per cutting and a greater percentage of rooted cuttings. No roots developed on cuttings placed in the perlite medium.

To make sure the medium temperature was kept near 70° F., a soil cable was buried in 2 inches of sand below the rooting medium. This proved to be unnecessary, since the greenhouse heating radiator, located directly under the cutting bed, supplied sufficient heat.

In order to provide a humidified atmosphere in the rooting bed, an automatic sprinkling device was set up with the use of a solenoid water valve and pressure regulator. The valve was controlled by a time clock that could be set to operate as frequently as every other minute. This clock, in turn, was regulated by another time clock to alter the frequency of watering during day and night. Several types of nozzles were tried, the best being a 90° oil burner nozzle having a rated discharge of 1.25 gallons per minute at 100 pounds pressure. The solenoid valve we used was operated between 65-70 pounds pressure, which produced an extremely fine mist resulting in a relative humidity of 50-65%.

Studies ^{on} varying the frequency of water discharge showed that a one-minute operation every hour during the day provided sufficient moisture to irrigate the cuttings and maintain humidity.

A photograph of a section of the rooting chamber presently in use is shown in Figure 1. The whole cutting bed is 3 feet wide and 10 feet long with the top of the chamber 3 feet above the bed. Three sides and the top of the chamber are covered with white muslin to provide shading during the summer months. Five pairs of 90° oil burner nozzles, suspended from the top of the chamber, provide a relatively even moisture coverage.

Over 70% of the cuttings made from good succulent seedstalks will root in this chamber in less than 2 weeks.

Since July 1, 1963, 452 successful clones involving 14 lines of sugarbeets have been made using this propagating chamber.

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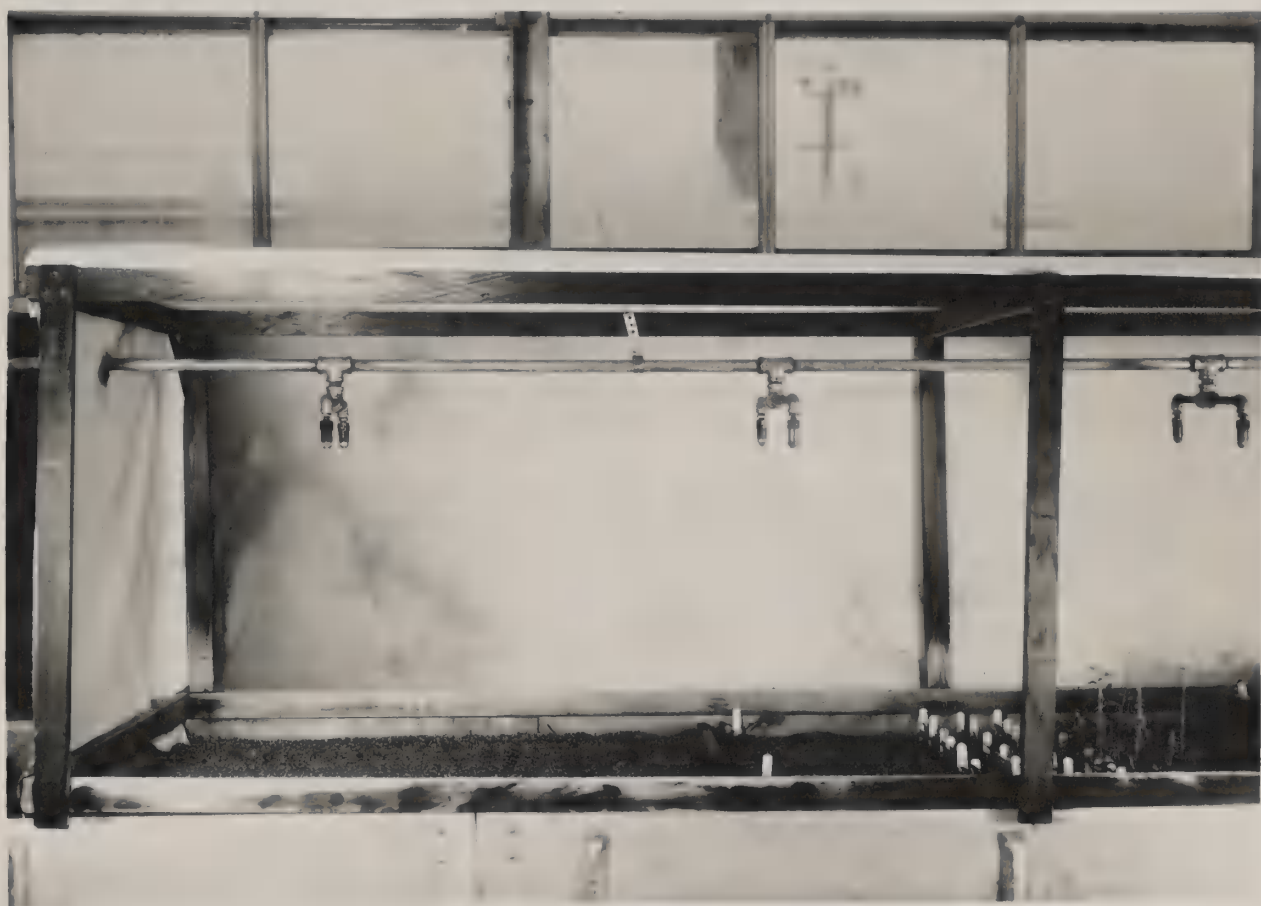


Figure 1. Propagation chamber showing construction over greenhouse bench

Variety Test, Logan, Utah 1963

G. K. Ryser and J. C. Theurer

The varieties in this test consisted of the best cytoplasmic male-sterile hybrids of the 1962 tests (1101, 1104, 1114, 1120, 1123, and 1128); 6 cytoplasmic male-sterile hybrids made in 1962 (2154, 2158, 2159, 2162, and 2165); 8 pollinators (0457, 0548, 0523, 0552-2, 0503, 0527, 711 and 712-13); 3 male steriles used as females in hybrids (0156, 0157, and 0158); and a high yielding check variety (9140).

The average gross sugar, tonnage, and sugar percentage were lower this year than in the 1962 test (Tables 1 and 2). The variety 1114 was the highest yielding variety and one of the highest in sugar percentage for both years. Two hybrids (1101 and 1104) having 0457 ((US 35/2 X Ovana) X CT 8 X CT 5) as a pollen parent were again among the high yielders. Seven varieties produced more sugar than the check 9140; however, only 1114 showed a significant difference. The check variety 9140 was the most curly top resistant variety with a reading of only 14.4% curly top.

The inbred lines, as expected, were the lowest in yield in the test. (Table 1 and 3). Of the pollen parents included in the variety test, 0457 was the highest yielding line but in turn showed the least resistance to curly top. Data indicate that this line has potential for increasing yield, if the resistance to curly top can be increased.

The combined sister lines 712 and 713 had significantly better sugar percentage than all others in the test with the exception of hybrid 2165, where another sister line 711 was used as the pollinator.

An indication of the combining ability of six pollinators crossed with the same male-sterile parent is given in Table 4. All crosses yielded more gross sugar than the average of the two parents with the magnitude of difference decreasing in the same order as gross sugar. Differences were mainly due to tonnage, as deviations from the midparent value for sucrose were negligible.

Variety Test, Logan, Utah, 1963
by G. K. Ryser

(Field history and experimental design)

SOIL TYPE: Silty clay loam.

PREVIOUS CROPS: Peas and barley 2 years previous, 1960 safflower,
1957 to 1959 alfalfa.

PLANTED: May 6, 1963.

THINNED: June 3 and 4, 1963.

IRRIGATIONS: Sprinkle only, on weekly schedule starting day after
planting.

CURLY TOP: No symptoms were noted on these varieties at Logan, but
these same varieties were planted in the curly-top testing field
at Thatcher by Albert Murphy, and the curly-top data given in
Tables 2 and 3 came from this source.

HARVESTED: October 16, 1963.

Tops were removed with a roto-beater and scalped with tractor-
mounted scalping tools, supplemented by long-handled hoe trimming to
assure a complete topping job. Beets in plots were counted (after scalping)
before lifting with the harvester. Ten-beet samples were obtained at
random from each of the two center rows of each four-row plot for sugar
analysis and all beets in the two center rows were weighed to determine
root yield.

Experimental Design: Twenty-five varieties planted as a balanced
lattice with six replications. Plots were four rows wide, 22 inches
apart, with a harvested plot length of 28 feet.

The test was analyzed as a lattice square and means reported in
Table 1 are corrected means where indicated.

Table 2 and 3 show the results of analyzing the data in two parts,
CMS hybrids and pollinators. The pollinators show large significant
differences as expected, because some are hybrids of two inbred lines.

Means of 6 hybrids having a common female parent are given in
Table 4. The hybrid combinations all seem to just meet the means of
the two parents in percent sugar with non-significant increases over
the average of the two parents in other measurements.

VARIETY TEST, NORTH FARM, LOGAN, UTAH, 1963
25 varieties, 6 replications of each variety
Balanced Lattice

Table 1

Code	Var. No.	Description	ACRE YIELD ^{1/}			PPM ^{2/}			Beets 100'
			Gross Sugar	Tons Beets	Percent Sugar	Amino N ^{3/}	Na	K	
24	1114	9132 X CT 5	9,152	32.7	14.0	193	184	1290	119
9	2159	0156 X 711 and 713	9,063	32.5	13.9	194	120	1285	114
13	1101	0157 X 0457	9,007	33.4	13.4	220	220	1348	115
11	1104	0168 X 0457	8,947	32.0	14.0	286	202	1294	108
6	0156	9142 X 924	8,790	31.6	13.9	183	186	1263	112
18	2154	1123 X 02.30.1	8,592	31.1	13.8	254	255	1375	106
12	0157	9142 X 95.68.3 SLC 133	8,446	33.7	12.5	238	292	1387	112
2	9140	7121 X CT 5 B	8,442	30.7	13.7	239	214	1292	110
25	2165	0156 X 711 rr	8,415	29.7	14.2	169	157	1270	115
16	2162	0156 X 0548	8,351	31.6	13.2	201	215	1405	113
3	2158	1120 X 711 and 713	8,300	29.7	14.0	184	177	1289	106
15	0168	9146 X 95.244.11	8,186	30.5	13.4	220	230	1151	115
22	9132	7121 X 87.55 SLC 129	7,909	29.0	13.6	192	222	1383	109
17	1128	0156 X 0552-3	7,872	28.6	13.8	172	155	1208	107
20	2163	0156 X 0523	7,817	28.5	13.7	167	197	1139	107
23	1123	0156 X SLC 132	7,460	28.1	13.3	192	232	1376	92
19	1120	0156 X 924 (CT 5)	7,476	27.4	13.6	193	174	1348	89
10	0457	630 aa X CT 5	8,385	30.0	14.0	252	197	1320	106
4	712 and 713	(CT 5 X CT 8)	7,730	26.3	14.6	188	177	1237	109
5	0548	SLC 129 X 132	6,943	28.0	12.4	219	257	1555	104
21	711 rr	CT 5 X CT 8	6,832	24.4	14.0	159	163	1167	110
8	0523	CT 5 mm	6,355	22.9	13.8	165	188	1195	96
14	0552-3	CT 5 mm subline	6,284	22.6	13.9	163	135	1156	90
7	0503	SLC 129	6,165	23.5	13.1	212	216	1377	97
1	0527	SLC 132	5,960	24.1	12.4	262	333	1438	92
General Mean of all varieties			7,875	28.91	13.62	205	207	1302	
S. E. of Mean			244	.89	0.16	18	15	47	
Sig. Diff.			682	2.49	.45	50	43	132	
Coefficient of Variation %			7.58	7.35	2.87	21.00	18.00	8.80	

Calculated F Values

16.28 **14.97 **12.28**3.82**8.15**4.62**

^{1/} Means not adjusted because of negative adjustment factor.

^{2/} Means adjusted by lattice design.

^{3/} True Amino N.

VARIETY TEST, NORTH FARM, LOGAN, UTAH, 1963
Hybrid Combinations Analyzed as Randomized Blocks

Table 2

Code	Var. No.	Description	ACRE YIELD		Percent Sugar	p.p.m.			% C.T. Sept. 30 ² / ₁
			Gross Sugar	Tons Beets		Amino N ¹ / ₁	Na	K	
24	1114	9132 X CT 5	9,152	32.70	13.98	194	189	1272	45.6
9	2159	0156 X 711 and 713	9,063	32.52	13.94	196	198	1305	47.5
13	1101	0157 X 0457	9,007	33.45	13.45	230	220	1353	34.4
11	1104	0168 X 0457	8,947	32.03	13.97	291	204	1304	42.8
6	0156	9142 X 924	8,790	31.63	13.90	184	186	1261	30.5
18	2154	1123 X 02.30.1	8,592	31.13	13.78	248	250	1351	53.2
12	0157	9142 X 95.68.3 (133)	8,446	33.67	12.53	240	289	1381	26.5
2	9140	7121 X CT 5 B	8,442	31.73	13.73	234	214	1287	14.4
25	2165	0156 X 711 rr	8,415	29.68	14.18	165	154	1259	38.6
16	2162	0156 X 0548	8,351	13.58	13.22	190	216	1404	44.6
3	2158	1120 X 711 and 713	8,300	29.67	14.00	179	178	1286	34.6
15	0168	9146 X 95.244.11	8,186	30.48	13.45	222	233	1162	27.9
22	9132	7121 X 87.55 (129)	7,909	28.98	13.62	184	218	1373	19.6
17	1128	0156 X 0552-3	7,872	28.55	13.78	174	159	1211	19.7
20	2163	0156 X 0523	7,817	28.48	13.72	166	199	1128	23.3
23	1123	0156 X SIC 132	7,460	28.07	13.28	194	234	1357	36.1
19	1120	0156 X 924 (CT 5)	7,476	27.40	13.63	202	171	1368	51.4
General Mean									
all Varieties			8,366	30.63	13.65	205.38	207	1298	
S. E. of Mean			258	0.87	0.16	18	16	47	
Sig. Diff. 19:1			729	2.43	0.45	50	47	132	
% Coefficient of Variation			7.55	6.95	2.85	21.10	19.4	8.79	

Calculated F. Values

4.23** 4.93** 6.07** 3.66** 4.29** 2.79**

¹/ True Amino N.

²/ Average of two replications. Information came from Thatcher disease nursery.
Readings made by Albert Murphy.

VARIETY TEST, NORTH FARM, LOGAN, UTAH, 1963
Pollinators analyzed as Randomized Blocks

Table 3

Code	Var. No.	Description	ACRE YIELD		Percent sugar	PPM			% C.T. Sept. 30
			Gross sugar	Tons beets		Amino N	Na	K	
10	0457	630 aa X CT 5	8,385	29.98	13.97	254	202	1325	50.0
4	712-713	CT 5 X CT 8	7,730	26.32	14.65	188	179	1229	42.5
5	0548	SLC 129 X 132	6,943	28.05	12.37	221	253	1563	31.8
21	711 rr	CT 5 X CT 8	6,832	24.43	13.98	154	161	1161	46.2 ^{1/}
8	0523	CT 5 mm	6,355	22.93	13.83	169	189	1216	19.3
14	0552-3	CT 5 mm (subline)	6,284	22.55	13.93	167	134	1165	21.2 ^{2/}
7	0503	SLC 129	6,165	23.5	13.10	214	216	1392	44.4
1	0527	SLC 132	5,960	24.12	12.45	258	329	1436	16.7
Mean of all Varieties			6,832	25.24	13.54	203	208	1311	
S. E. of Mean			260	0.92	0.18	21	14	51	
Sig. Differ.			736	2.59	0.51	59	41	144	
% Coefficient of variation			9.33	8.89	3.27	25.15	16.91	9.48	

Calculated F values 10.48** 8.43**20.13** 3.64** 17.75**8.08**

^{1/} Average of two replication unless otherwise noted. Readings made at Thatcher disease nursery by Albert Murphy.

^{2/} One replication.

VARIETY TEST, NORTH FARM, LOGAN, UTAH, 1963

Table 4

Code	Var. No.	Description	ACRE YIELD		Percent sugar	PPM		
			Gross sugar	Tons beets		Amino N	Na	K
9	2159	0156 X 712 and 713	9,063	32.52	13.94	196	198	1305
25	2165	0156 X 711 rr	8,415	29.68	14.18	165	154	1259
16	2162	0156 X 0548	8,351	31.58	13.22	190	216	1404
17	1128	0156 X 0552-3	7,872	28.55	13.78	174	159	1211
20	2163	0156 X 0523	7,817	28.48	13.72	166	199	1128
23	1123	0156 X SLC 132	7,476	27.40	13.63	202	171	1368
Mean			8,166	29.70	13.74	183	183	1279

FURTHER STUDIES ON THE VIABILITY OF SUGARBEET SEED STORED AT LOW TEMPERATURES VERSUS NORMAL SEED STORAGE

By Clifton H. Smith

Section I. Long-term germination studies on German sugarbeet variety used in commercial sugarbeet plantings.

A seed storage experiment at low temperatures was begun March 8, 1928, by Dr. Dean A. Pack^{1/}. Two five-pound samples were placed in tin can containers; one can was sealed and the other remained unsealed. The cans were placed in a commercial cold storage plant where temperatures were maintained at 0° F. The seed used was the German variety Braune, reproduced in St. George, Utah, in 1927. To eliminate small seed, the samples were run over a 7/64" screen. Upon examination of the seed in 1938, the cans were found to be rusted and perforated with holes. The seed was then changed to cloth bags. On July 3, 1942, the seed was taken to Hygeia Ice Company for storage, where it remained until July 1, 1961, when it was transferred to a deep-freeze unit at the present Sugarbeet Investigation Facility at Logan, Utah. At this time, part of the seed was placed in glass bottles to determine if this might be an aid in maintaining seed viability.

The following standard germination procedure was followed for testing seed viability on the various dates indicated in this paper. Seed samples containing 100 seed balls each were washed in running water for three hours and placed between moistened blotting paper stamped with 100 indentations to accommodate 100 seed balls. These samples were then placed in a moist chamber or germinator where high humidity and a temperature of 72° to 75° F. were maintained. At intervals of 3, 6, 10, and 14 days counts were made and recorded of number of sprouts and percent germination.

^{1/} Dr. Dean A. Pack was formerly Physiologist, Division of Sugar Plant Investigations, Bureau of Plant Industry, Soils, and Agricultural Engineering, Agricultural Research Administration, U. S. Department of Agriculture.

Table 1 - Germination of sugarbeet seed held
35 years in cold storage (1928-1963)

Date	Length of Storage years	Percent Germination	Tested by
1928	0	83.5	D. A. Pack
1942	14	86.5	Myron Stout
1947	19	85.0	W. J. Musser
1948	20	75.0	Betty Nielsen
1949	21	81.0	Betty Nielsen
1950	22	75.0	C. H. Smith
1960	32	33.1	C. H. Smith
1963	35	22.1	C. H. Smith
1963 <u>1/</u>	35	34.0	C. H. Smith

1/ Sample removed from cold storage in 1950 and stored at
regular storage.

Table 1 shows combined data compiled by Dr. F. V. Owen and reported in the 1950 A.S.S.B.T. Proceedings^{2/} with additional data obtained by the writer in 1960 and 1963. Tests made in 1950 show a reduction of 8 1/2 percent from the original seed germination. By 1960 the germination had been reduced 50 percent. 1963 germination tests showed a further reduction in germination. The earliest sprouts appearing in the 1963 tests had good vigor, but those on the 10- and 14-day counts were weak and very much shortened ~~as~~ they emerged from the seed balls. Samples of seed taken from cold storage in 1950 and stored in regular storage showed less reduction of germination and less loss of vigor of 10- and 14-day sprouts. This data would indicate that for the Braune variety, seed viability and vigor of seedlings may both be affected more severely in cold storage than in regular seed storage. It is unfortunate that no seed samples of the Braune variety were stored under normal seed storage for comparison with samples stored in cold storage temperatures.

Section II. Long-term germination studies on curly-top-resistant varieties of sugarbeets.

On May 17, 1938, the writer began a seed storage experiment at 00 F. temperature with five curly top resistant varieties. Control samples of the same numbers were also placed in regular storage located in a fire-proof, unheated warehouse. Unfortunately, the sample of one number (618) maintained in the warehouse was lost, which eliminated a comparison of cold versus normal seed storage for this variety.

From the results in Table 2, differences were noted among varieties for storageability at cold temperatures as well as at normal seed storage. The tendency of germination to fluctuate in some varieties is unexplainable. Number 9.153 was an example of this fluctuating tendency. In normal storage the germination decreased from 68% in 1938 to 27% in 1947. A similar percentage was noted in 1960, but in 1963 the germination was up to 40%. Seed stored in cold storage showed a drop from 68% to 40.5% in 1947 and an additional decrease to 28.3% in 1960. However, in 1963 the germination was up again to 46.7%. Number 3407 maintained its germination at low temperatures but showed a decline at regular storage. Number 722 showed a rapid decline in regular storage. At cold temperature germination of 722 declined 20% during the first ten years but remained constant thereafter. Number 717 gave no indication of a decline in germination

^{2/} Viability of Sugarbeet Seed Held in Cold Storage for 22 Years.
D. A. Pack and F. V. Owen. 1950 A.S.S.B.T. Proceedings.

Table 2 - Viability of sugarbeet seed held 25 years in storage. (1938-1963)

Number	Variety	Type of Storage	Germination percent - year				
			1938 ^{1/}	1947	1960	1963 A	1963 B
9.153	US # 1	Regular	68.0	27.0	30.3	40.0	
		Cold		40.5	28.3	46.7	45.7
3407	Factory # 1	Regular	81.0	59.5	33.7	39.0	
		Cold		96.5	91.3	93.4	96.0
722	US 22	Regular	82.0	54.0	29.0	18.3	
		Cold		62.0	64.3	66.7	69.0
717	US 15	Regular	53.0	74.5	65.3	61.0	
		Cold		60.0	53.7	53.7	46.4
618	US 12	Cold	79.0	59.0	59.7	58.6	71.7

A. Seed stored in cloth bags.

B. Part of seed previously stored in cloth bags was transferred to glass jars in 1961 when transferred to the Logan facility.

1/ Original germination at harvest.

at either normal or cold temperature storage. The increase in germination at normal storage is difficult to explain. Number 618 showed a decreased germination during the first ten years at cold temperatures but remained constant thereafter. The rise in germination from the samples of seed placed in bottles in 1961 is unexplainable. However, the seed stored in cloth bags may have absorbed moisture from the air or the bottled seed may have had an accumulation of CO_2 from respiration of the seed, which could account for the difference in viability of the two samples of seed of variety number 618. No measurement was made to determine moisture content of the seed or accumulation of CO_2 in bottled versus bagged seed.

A field planting was made in June 1963 to study emergence and plant vigor of seed stored for both 25- and 35-year periods in cold storage compared to regular storage. Six replications of each variety and each treatment were planted. Emergence readings corresponded well with germination percentages noted in previous tables. Vigor ratings were all good without variation between high or low germination percentages. The only variation in vigor noted was strictly varietal and not between treatments or germination percentages. In the presence of good moisture conditions, seedling growth was rapid in all varieties and treatments.

It is concluded that many of the disturbing factors affecting germination of seed are associated with differences in the physiological make-up of varieties, the differences occurring among seed lots of the same variety, as well as a multitude of other combinations of factors. Controlled tests to eliminate as many as possible of the factors adversely affecting seed viability should be employed in searching for methods of storing and maintaining seed viability for long periods of time.

Curly Top Disease Investigations

C. L. Schneider

Materials and Methods

Beet leafhoppers were employed in curly top inoculation experiments in the greenhouse. Colonies of non-viruliferous leafhoppers were maintained on sugarbeets and Beta maritima at about 80° F. The insects were caged on curly top plants for approximately 7 days to acquire the virus.

Inoculation tests were conducted in the greenhouse maintained at about 75° F. Host plants were grown in shallow 6" clay pots of steam-sterilized soil. To maintain adequate soil fertility, 100 ml of Hoagland's solution were added to each pot of seedlings per week. Inoculation of seedlings was accomplished by attaching small glass cages, each containing one viruliferous leafhopper, to cotyledons about 2 weeks after planting. Curly top symptoms generally began to appear after about 5 days. Records of incidence of infection and degree of curly top severity were taken about 6 weeks after inoculation.

Virulence of Curly Top Isolates from Northern Utah

In 1962, 20 curly top cultures were isolated from the following 2 sources in northern Utah; (1) beet leafhoppers collected in the desert near Promontory; (2) infected plants of curly top resistant sugarbeet strains growing in the curly top nursery at Thatcher. Sub-cultures were subsequently isolated from each culture employing methods that were probably selective for the more virulent strains of the virus. Leafhoppers from plants infected with the original virus cultures were transferred serially to sugarbeet seedlings of a highly resistant variety and allowed to feed for approximately 12 hours on each plant. From the comparatively few seedlings that developed curly top, the sub-cultures employed in the subsequent tests were established.

In greenhouse inoculation tests, the virulence of 27 sub-cultures was compared on 3 sugarbeet varieties; SL 68 (highly resistant to curly top); US 75 (moderately resistant); SL 742 (highly susceptible) and on Turkish tobacco. Most of the isolates were also tested on Gomphrena globosa, Celosia cristata and on tomato (variety Marglobe). Two leafhoppers were used to inoculate each plant of tobacco and tomato; one leafhopper per plant was used for all the other species.

Differences in virulence between the curly top isolates were noted (Table 1). Most of the isolates were equal in virulence to highly virulent strain 11. The curly top severity rating of variety US 75 infected with this strain was 3.9. At least one of the isolates tested (A 26 A) was more virulent than strain 11. As a group, the isolates from the leafhoppers collected in the desert were as virulent as those from the sugarbeet hosts. All isolates tested on tomato caused severe curly top symptoms. With a few exceptions, the isolates were pathogenic on tobacco, Gomphrena and Celosia.

Among the 3 sugarbeet varieties, there was a high degree of association between their reactions to each curly top isolate (Tables 2 and 3). The reactions of sugarbeet and Gomphrena to each isolate were also significantly associated (correlation coefficient = .560 **). The reactions of sugarbeet and tobacco did not appear to be significantly associated (correlation coefficient = .183).

These results show that curly top strains capable of causing severe damage to sugarbeet varieties previously designated as highly resistant, occur in desert and in sugarbeet growing areas of northern Utah. These isolates differ in degree of virulence on sugarbeet varieties but no differential response to the isolates was noted among the 3 varieties tested.

Some Factors Affecting Development of Curly Top in the Greenhouse

In testing sugarbeet strains in the greenhouse for resistance to curly top, the number of plants to be inoculated and evaluated is usually limited; therefore, a high incidence of infection is desirable. To standardize greenhouse inoculation procedures towards a greater and more uniform incidence of curly top infection, studies were made to determine the effect of the following factors on curly top development: age of plants when inoculated; number of leafhoppers applied per plant; stage of leafhopper vector, length of sojourn of leafhopper on curly top source plant, and effect of preinoculation starvation period of leafhopper vector.

Incidence and severity of infection decreased with increase of age of seedlings from 21 to 35 days (Table 4). Increasing the number of caged leafhoppers per test seedling from 1 to 2 increased incidence and severity of infection on a resistant and susceptible sugarbeet variety. (Table 5). No differences in incidence and severity of infection were noted between plants on which viruliferous leafhopper nymphs and those on which viruliferous adults had fed. Varying the feeding time on curly top source plant from 1 to 3 weeks had no effect on subsequent development of curly top, nor did starvation periods of 0 to 50 hours from the time the insects were removed from the virus source plant until they were placed on the seedlings to be inoculated.

Table 1 - Virulence of 27 curly top virus cultures isolated from Northern Utah in 1962

Source and culture number of curly top isolates	Curly top severity ^{1/} on sugarbeet varieties			Incidence of infection on other hosts				
				No. of plants with curly top		No. of plants inoculated ^{2/}		
	SL 68	US 75	SL742	Turkish Tobacco	Gomphrena globosa	Celosia cristata	Tomato	Shepherd's purse
From sugarbeet leafhoppers collected in desert near Promontory, Utah								
A 1 A	3.3	3.9	5.2	6/24	3/8	6/14	----	5/10
A 1 C	3.9	4.3	5.3	5/25	3/5	3/5	7/10	
A 3 A	3.6	4.3	5.2	5/8	5/8	2/8	7/10	
A 3 B	3.7	4.2	5.5	4/20	10/13	7/13	7/10	
A 3 C	3.4	3.8	5.2	2/16	---	1/16	7/10	
A 4 D	3.7	4.2	5.2	2/10	---	---	---	
A 7 A	3.3	3.6	4.6	4/20	7/20	5/24	35/40	5/5
A 21 A	3.3	3.9	5.5	3/20	---	---	---	
From sugarbeet plants in curly top nursery at Thatcher, Utah								
A 8 A	2.9	3.3	4.8	1/15	3/4	0/8	---	
A 9 B	3.4	3.6	5.2	2/10	6/8	6/10	1/10	
A 9 C	3.6	4.0	5.2	5/15	4/4	1/8	7/10	
A 10 A	3.3	3.8	5.6	3/45	3/4	---	21/40	
A 11 B	3.9	4.2	5.4	3/26	10/20	3/5	2/10	6/6
A 12 A	3.5	3.7	5.4	9/20	7/7	3/4	5/10	
A 12 B	3.5	3.8	5.2	10/10	---	7/8	---	
A 12 C	3.5	4.5	5.2	2/10	7/8	3/12	---	
A 13 B	4.2	4.3	5.9	6/20	5/6	6/8	35/50	
A 15 B	2.8	3.2	4.5	1/21	0/2	0/8	---	
A 16 B	3.3	3.9	5.1	3/15	8/8	5/8	---	
A 17 B	3.3	3.7	5.4	1/27	0/4	---	3/10	
A 17 C	3.6	4.0	5.2	6/20	4/4	4/8	10/10	
A 18 B	3.0	3.8	5.2	0/15	3/4	---	6/10	
A 19 B	3.1	3.4	4.3	11/20	---	---	5/7	
A 23 A	3.0	3.1	4.4	10/20	5/8	---	---	
A 24 A	3.4	4.0	5.3	3/20	2/4	---	5/10	
A 25 A	3.1	3.3	4.5	11/17	13/24	---	7/10	
A 26 A	4.0	4.7	5.3	16/20	5/8	7/8	---	

^{1/}Results expressed as mean of 2 tests, each comprising 12-20 plants. Severity ranged from 0 (no disease) to 6 (dead).

Table 2 - Distribution of 27 curly top cultures according to virulence on Sugarbeet varieties US 75 and SL 68: Number of cultures occurring in each host-reaction class.

SL 68 curly top severity classes ^{1/} (Y)	US 75 curly top severity classes ^{1/} (X)			
	3.1 - 3.5	3.6 - 4.0	4.1 - 4.5	4.6 - 5.0
4.1 - 4.5	---	---	1	---
3.6 - 4.0	---	2	5	1
3.1 - 3.5	2	11	1	---
2.6 - 3.0	3	1	---	---

Correlation coefficient (r_{XY}) = .884 **

^{1/} Host reaction classes based on ascending scale: 0 (no symptoms) to 6 (dead). Results expressed as mean of 2 tests.

Table 3 - Distribution of 27 curly top cultures according to virulence on sugarbeet varieties US 75 and SL 742: Number of cultures in each host reaction class.

SL 742 curly top severity classes ^{1/} (Y)	US 75 curly top severity classes ^{1/} (X)			
	3.1 - 3.5	3.6 - 4.0	4.1 - 4.5	4.6 - 5.0
5.6 - 6.0	---	1	1	---
5.1 - 5.5	---	12	6	---
4.6 - 5.0	1	1	---	---
4.1 - 4.5	4	---	---	---

Correlation coefficient (r_{XY}) = .679 **

^{1/} Host reaction classes based on ascending scale: 0 (no symptoms) to 6 (dead). Results expressed as mean of 2 tests.

Table 4 - Effect of age of sugarbeet plants when inoculated on subsequent development of curly top on varieties SL 68, US 75, and SL 742 in the greenhouse.

Age of plants (days)	Plants infected ^{1/} (percent)			Curly top severity ^{1/}		
	SL 68	US 75	SL 742	SL 68	US 75	SL 742
21	81	81	94	3.8	3.9	5.7
28	62	94	94	3.0	3.3	5.3
35	44	56	100	2.8	2.6	4.2

^{1/} Data expressed as mean 4 replicates of each variety - treatment combination (16 plants).

Table 5 - Effect of number of viruliferous leafhoppers per plant on subsequent development of curly top on sugarbeet varieties US 22/4 and SL 742 in the greenhouse.

Number of leaf- hoppers per plant	Presymptom period ^{1/} (days)		Plants infected ^{1/} (percent)		Curly top severity ^{1/}	
	US 22/4	SL 742	US 22/4	SL 742	US 22/4	SL 742
1	15.3	12.2	65	70	3.6	5.1
2	17.9	10.5	70	90	3.9	5.7

^{1/} Results based on 5 replicates of each variety treatment combinations (20 plants).

Evaluation of Sugarbeet Strains in the Greenhouse for Resistance to Curly Top

In a series of inoculation tests in the greenhouse, 58 sugarbeet strains were evaluated for resistance to curly top isolates equal in virulence to Gidding's strain 11. In each experiment comprising usually 10 varieties, was included moderately resistant variety US 75 as a standard of comparison. Highly susceptible line SL 742 was also included in each test as a check on the potential of the inoculation treatment. Highly resistant variety US 22/4 was included in most tests. Twenty plants of each strain were tested.

Incidence of infection and severity of curly top of 3 varieties included in each of 6 tests varied from test to test (Table 6). Consequently, curly top evaluations of entries from different tests can probably be more accurately compared if expressed in percent of that standard check variety included in each test.

Curly top incidence on the 58 sugarbeet strains ranged from 37 to 185 percent of check variety US 75. Curly top severity ratings ranged from 70 to 134 percent. Analysis of the results shows that incidence of infection and degree of curly top severity tended to be associated among the 58 strains tested (Table 7). The greenhouse method of testing for curly top resistance therefore permits discrimination between a fairly wide range of degrees of resistance, even with highly virulent curly top isolates.

Table 6 - Differences in incidence and severity of curly top in 3 sugarbeet varieties in 6 greenhouse experiments.

Experiment No.	Variety ^{1/} US 75		Variety ^{1/} SL 742			Variety ^{1/} US 22/4		
	C. T. Incidence (percent)	C. T. Severity	C. T. Incidence (percent)	C. T. Severity	C. T. Severity in pct. US 75	C. T. Incidence (percent)	C. T. Severity	C. T. Severity in pct. US 75
1	55	4.0	85	5.6	140	40	3.9	98
2	35	3.8	45	4.9	129	30	3.3	87
3	55	4.1	80	5.0	122	35	3.5	85
4	55	3.5	85	5.1	145	35	3.0	86
5	70	4.1	75	5.3	129	55	3.8	93
6	75	4.1	85	4.9	119	67	3.6	88
C. T. Severity Range	3.5 - 4.1		4.9 - 5.6			3.0 - 3.9		

^{1/} Results expressed as mean of 5 replicated pots in each experiment. (20 plants).

^{2/} C. T. severity based on ascending scale from 0 (no symptoms) to 6 (dead).

Table 7 - Distribution of 58 sugarbeet lines according to incidence and severity of curly top in greenhouse tests: Number of lines in each class.

Curly top severity in percent of US 75 (Y)	Curly top incidence in percent of US 75 (X)								
	21-40	41-60	61-80	81-100	101-120	121-140	141-160	161-180	181-200
121 - 135	---	---	---	---	---	---	---	1	---
111 - 120	---	---	---	---	---	1	---	---	1
101 - 110	---	---	---	---	1	---	---	---	1
91 - 100	---	---	---	9	3	---	---	---	---
81 - 90	2	---	7	11	1	---	1	---	---
71 - 80	---	1	3	5	2	1	---	---	---
61 - 70	---	1	1	5	---	---	---	---	---

Correlation coefficient (r_{XY}) = .542 **

Curly Top Screening Test, Thatcher, Utah
by Albert M. Murphy

The curly top test of 1963 was in the same field as the test of 1962 and the available area consisted of about 3 1/2 acres.

Buffer areas of the curly top susceptible European variety were planted on each end of the field as well as in strips 15 feet wide crosswise of the field at 100-foot intervals. This material was planted May 7. Mother beets infected with curly top virus were transplanted at intervals within these strips also early in May. The test plots varied in size from single rows 25 feet long to two-row plots 50 feet long, while material planted for the purpose of making selections consisted of blocks 16 rows wide and 50 feet long. In 1963 more single-row plots were planted and less space devoted to block plantings, because of the unexpected requests for space. The reason for the high number of requests by so many breeders for space for a few to several varieties is not entirely clear. It is, however, an indication on the part of industry that curly top can still cause serious losses, if conditions are such that make a curly top epidemic possible. Curly top is a very cooperative disease and in many areas occurs in association with certain other diseases, which has had an alarming effect on both yield and sucrose.

The curly top exposure developed in the breeding field in 1963 was classed as being of moderate intensity. Thus, a remarkable degree of success was attained, since the incidence of curly top appearing in susceptible crops in northern Utah and southern Idaho was almost nonexistent in 1963.

The curly top epidemic was very slow developing, for two reasons: (1) very few adult leafhoppers moved into the field, and (2) the spring was very wet and cold, which greatly retarded the reproduction of the leafhopper and the development of the disease. By delaying the planting of test material until the latter part of June, the curly top exposure was adequate to evaluate the bulk of material under test; however, it was not severe enough to bring out the differences in resistance in highly resistant material where it was suspected some lurked. The fall weather was beautiful and a killing frost did not occur until October 23, and even though planting was late and curly top got off to a slow start, the total amount of disease that developed was truly astonishing.

Generally speaking, it is more difficult to produce a uniform epidemic of a light or of a moderate nature than a severe or heavy one, because there are too few leafhoppers to feed and thus spread the disease rapidly. This was especially true in the 1963 test, as in some cases there were considerable differences between replications. However, due to lack of space (also seed, in many cases) it was not possible

to have enough replication to minimize this difference. In spite of this it is felt that in the 1963 test, by and large, the goal was attained, in that entries under test were correctly classed as to the degree of curly top resistance they possessed. However, when testing so many varieties there is always a chance that a particular number may be incorrectly classed. At any rate, the varieties used as checks reacted to curly top exposure produced, in the proper manner.

Breeding material was screened for a few of the western beet sugar companies and in addition to Logan Laboratory, for the following ARS investigators: Coe, Gaskill, McFarlane, and Savitsky. Selections at harvest were made for all ARS breeders except J. S. McFarlane.

In the interest of space it is not feasible to report all data obtained in a separate section; therefore, pertinent information will appear in this report at the option of the many cooperators in the project.

Photosynthesis and Respiration Studies on Sugarbeets.

By Myron Stout

Photosynthetic and respiration rate studies on intact sugarbeet plants were made by monitoring changes in CO_2 concentration within a closed system. The constant-temperature water-jacketed chamber is 22" X 22" square and 21" deep. Water is rapidly circulated on all sides and to a depth of 2 1/4-inches above the glass top of the chamber before overflowing to the constant-temperature bath. Heat from lights mounted above is absorbed by the water before entering the plant chamber. An electric fan inside the chamber continuously circulates air and insures a uniform mixture of gases to the leaves and to inlet and outlet sampling tubes.

A Beckman CO_2 analyzer, connected to a strip chart recorder, makes a continuous record of CO_2 concentration changes. The instrument is calibrated by means of a standard mixture of CO_2 in nitrogen. Total milligrams of CO_2 in the system is determined by absorption of all CO_2 , then adding known amounts of CO_2 by means of a 50 ml hypodermic syringe. Net accumulation or respiration rate values can then be made at any given temperature, light intensity and CO_2 concentration, by plotting the slope of the line at a given CO_2 concentration and measuring the time required to change the total CO_2 content between measured, arbitrary values.

Total leaf area of plants is determined by tracing each leaf on a uniform-weight bond paper, cutting out the tracings and weighing the paper. Net accumulation or respiration rate values are calculated in milligrams of CO_2 per decimeter of leaf area per hour. Photosynthetic rates can be estimated by adding the net-accumulation and respiration-rate values. A schematic diagram of the equipment is shown in Figure 1.

Effect of Foliar Density

Net-accumulation and respiration-rate values were determined on normal sugarbeet plants. Vertical and profile photographs were taken to record normal foliar arrangement. The foliage was then rearranged by placing a rubber band around all petioles or tying them in stacks of 2 to 4 petioles. Vertical and profile photographs were again taken to record the modified foliar arrangement, then net accumulation and respiration rates were redetermined.

At a light intensity of 1500 foot-candles and 25° C., the net-accumulation rate of plants having about 1/2 or more of the leaves exposed to direct light reduced the net accumulation rate to 1/2 the previous value. The respiration rate was reduced only slightly by

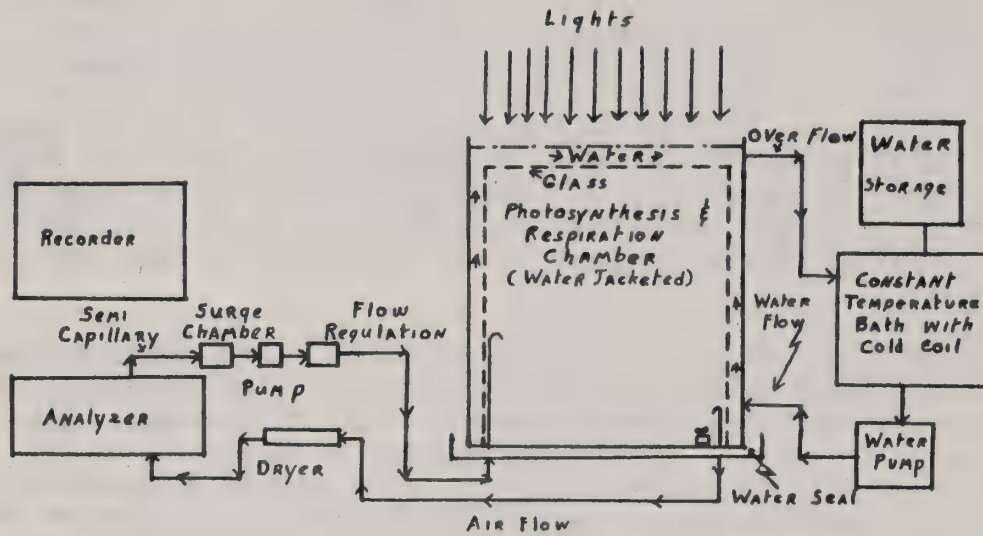


Figure 1 - Schematic diagram and flow-sheet of equipment to measure respiration and net accumulation rates of sugarbeet plants.

increasing foliar density. This degree of foliar shading may be encountered in closely spaced plants in the field under high nitrogen nutrition. Some tests with more closely packed leaves resulted in no decrease in CO₂ concentration with 1500 foot-candles of light at 25° C. Typical data for a plant of variety 202H9 before and after reducing foliar exposure are shown in table 1. The appearance of the plant before and after reducing the foliar exposure is shown in figure 2.

The effect of stacking the foliage on net accumulation and respiration rates is shown in table 2 and figure 3. A comparison of the data and figures in tests 5 and 14 indicate that the loosely bunched foliage in test 5 reduced photosynthesis more than stacking of foliage in test 14.

The technique is believed to be especially suitable for studies of the effects of diseases on major physiological processes.



Figure 2 - Profile and vertical views of sugar-beet plant with normal (above) and bunched (below) foliar arrangement. Test No. 5.

Table 1 - Test No. 5. Date 9/24/63, temperature 25° C. Lights 5-150 W foot-candles 1500

	Foliage	
	Normal	Bunched
Mg CO ₂ between scale 5 and 7	21.6	21.6
Seconds required for 21.6 Mg CO ₂ uptake	600.	1550.
Total leaf area (decimeters)	8.00	8.00
Net accumulation rate Mg CO ₂ /DM/hour	16.21	6.27
Seconds required for 21.6 Mg CO ₂ evolved	2090.	1960.
Respiration rate Mg CO ₂ /DM/hour	4.66	4.96
Net accumulation/respiration	3.48	1.26



Figure 3 - Profile and vertical views of sugarbeet plant with normal (above) and stacked (below) foliar arrangement. Test No. 14.

Table 2 - Test No. 14. Date 10/16/63, temperature 25° C. Lights 5-150 W foot-candles 1500

	Foliage	
	Normal	Stacked
Mg CO ₂ between scale 5 and 7	21.6	21.6
Seconds required for 21.6 Mg CO ₂ uptake	645.	985.
Total leaf area (decimeters)	11.9	11.9
Net accumulation rate Mg CO ₂ /DM/hour	10.1	6.64
Seconds required for 21.6 Mg CO ₂ evolved	1200.	1580.
Respiration rate Mg CO ₂ /DM/ hour	5.42	4.14
Net accumulation/respiration	1.87	1.60

Effects of Previous Light Exposure on Respiration of Sugarbeet Leaves

by Myron Stout

Previous attempts, by the writer and others, to relate leaf respiration rates of sugarbeets to genetic or other characters, have met with extreme variation between samples. Variation with time-of-day, different days, and different leaves taken at one time makes the data unreliable. The present studies were undertaken to determine some of the causes of this erratic behavior.

One-half of leaves previously exposed to full sunlight were enclosed in cardboard containers for varying periods before sampling for respiration rate measurements by the Warburg technique. Uniform samples 19 by 66 mm. were cut by means of a sharpened rectangular metal cutter. Respiration-rate measurements were made at 20° C. All data are reported in percentage of the respiration rate or dry weight of the darkened half of the same leaf. Each point on the figures represents the average of six measured comparisons.

The data in figure 1 show a progressive increase in respiration rate of irradiated over darkened halves of the same leaves. Figure 1 also shows a progressive increase in dry weight of irradiated halves of leaves.

As a further check on the apparent cause of differences, potted sugarbeets were kept in the dark overnight, then half-leaves were exposed to sunlight before sampling. The half-leaf covers were installed in subdued light, then all six plants were wheeled into sunlight for varying periods before sampling.

The data in figure 2 show a much more rapid response in respiration rate and dry weight of previously darkened leaves.

The data indicate that changes in respiration rate and dry weight of leaves may be due to rather rapid changes in respiratory substrate in the leaf tissues. It apparently requires a considerably longer time to effect a differential concentration in the leaf tissues by translocation of the products of photosynthesis from the leaf than it does to create a difference by direct photosynthesis; although the magnitude of the differences is similar.

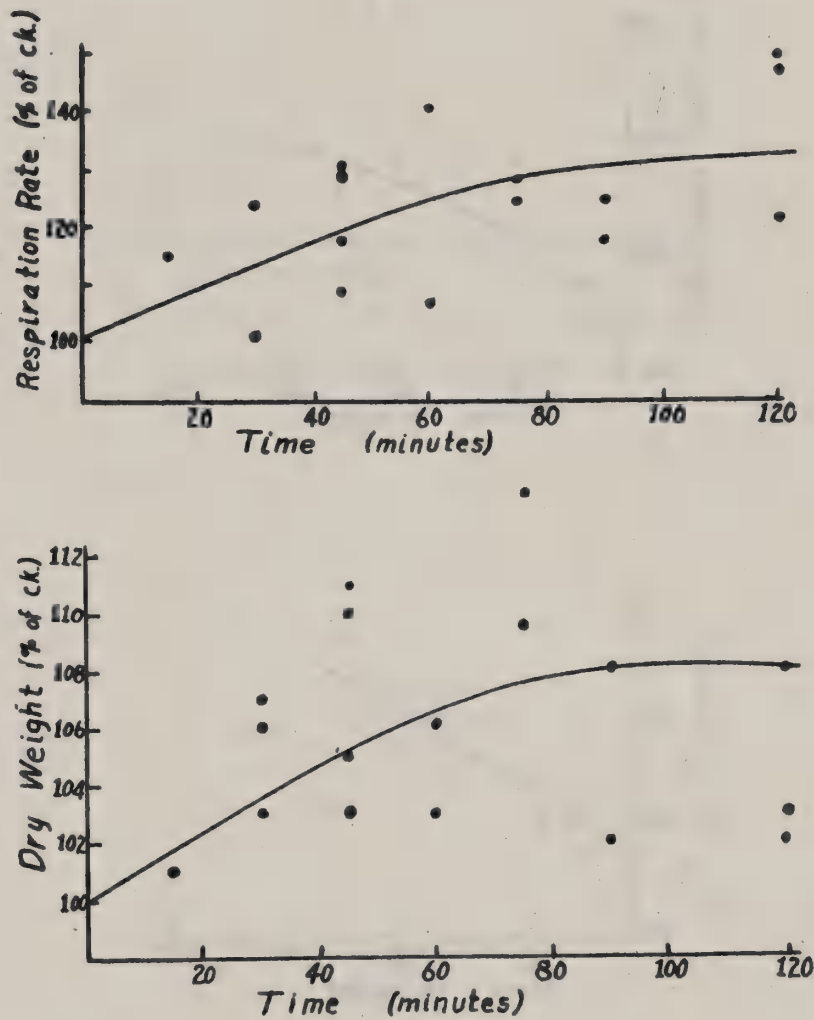


Figure 1 - Time vs respiration rate (upper figure) and dry weight (bottom figure) of half-leaves left in sunlight compared to darkened (check) halves of the same leaves.

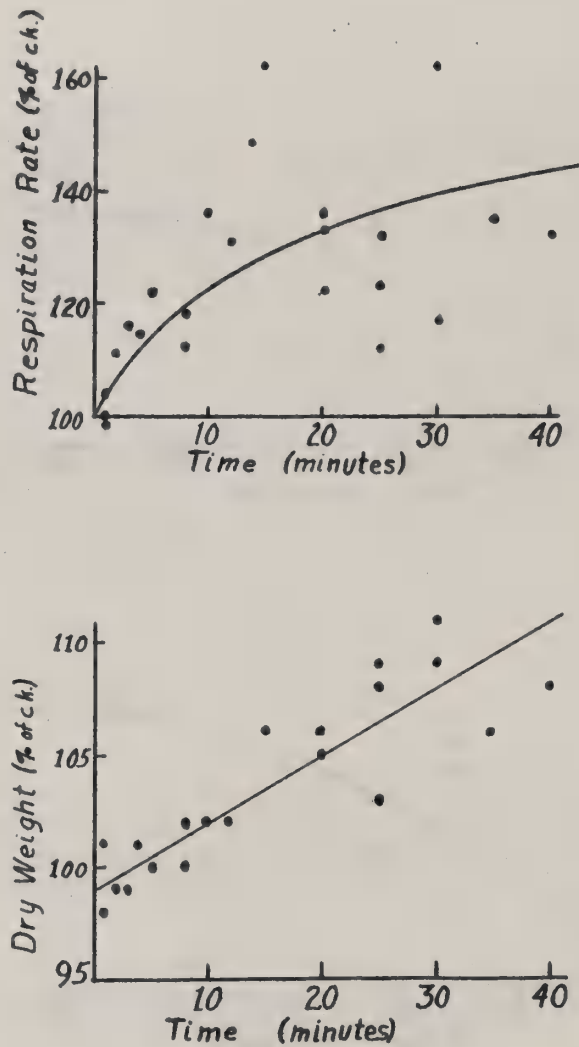


Figure 2 - Time vs respiration rate (upper figure) and dry weight (bottom) of half-leaves exposed to sunlight compared to halves of the same leaves kept in darkness.

P A R T IV

EVALUATION OF BASIC BREEDING MATERIAL
AND VARIETIES OF SUGARBEETS
SUITABLE FOR THE GREAT LAKES REGION

Foundation Project 26

G. E. Coe

D. L. Mumford

G. J. Hogaboam

Cooperation:

Farmers & Manufacturers Beet Sugar Association
Buckeye Sugars, Inc.
Canada and Dominion Sugar Company, Ltd.
Michigan Sugar Company
Monitor Sugar Division
Northern Ohio Sugar Company
Michigan Agricultural Experiment Station
Wisconsin Agricultural Experiment Station
Western Ontario Agricultural School, Ridgetown, Ontario

EVALUATION OF SUGARBEET VARIETIES AND BASIC BREEDING MATERIAL SUITABLE FOR THE GREAT LAKES REGION

The cooperative field trials of 1963 in the Great Lakes region were a continuation of a program of annual evaluations of sugarbeet varieties, hybrids, and basic breeding material for local and regional adaptation. The several items available for evaluations were separated into three categories for testing, and accordingly the results are presented in three sections: 1) Regional field tests of advanced hybrids and varieties that are candidates for grower use; 2) miscellaneous breeder seed, inbred lines, and experimental hybrids (p. 149); and 3) combining-ability tests to appraise selected pollinators and male-sterile lines (p. 161).

Section 1. Regional Field Tests of Hybrids and Varieties

The objectives of the cooperative regional field tests were a further appraisal of the monogerm hybrid that has largely superseded multigerm varieties in the region and a determination of whether additional productivity could be attained through the introduction of new hybrids that could be made available for grower use.

The regional tests for the evaluation of six varieties were planned by G. J. Hogaboam (Geneticist, USDA) and M. R. Berrett (Director of Research, F & M) and conducted jointly with company members of the Farmers & Manufacturers Beet Sugar Association: Canada and Dominion Sugar Co. (p. 124), Monitor Sugar Division (p. 130), Michigan Sugar Co. (p. 132), and Buckeye Sugars, Inc., (pp. 126 and 128). In addition, tests were conducted by Western Ontario Agricultural School, Ridgetown, Ontario (p. 138), and Hancock Experimental Farm, College of Agriculture, University of Wisconsin (p. 140). Three varieties were included in field trials conducted by the Northern Ohio Sugar Co. (pp. 142-148).

Results.--The performances of six varieties in six regional tests are summarized on page 123. Although each of the monogerm hybrids had a multigerm pollinator (SP 5822-0 or SP 5460-0), the processed seed was monogerm. The average values for SP 5822-0, the multigerm variety in the tests, may be taken as a standard of performance for the appraisal of the monogerm varieties.

The monogerm hybrids SL 122 ms X SP 5460-0 and SL 126 ms X SP 5460-0 did not differ significantly in percentage sucrose or clear juice purity, but in yield of roots and recoverable sugar a superiority was shown for the hybrid with SL 126 ms as the seedbearing parent. SL 122 ms X SP 5460-0, the first monogerm hybrid used extensively in the Great Lakes region, will be largely superseded in 1964 by the more productive hybrid SL 126 ms X SP 5460-0.

The hybrids SL 128 ms X SP 5822-0 and [(SL 122 X SL 128) X SL 126]ms X SP 5822-0 each exceeded significantly the other entries including SP 5822-0, the pollinator, in yield of roots and recoverable sugar. The marked similarity of

performance of these two hybrids indicates that if SP 5822-0 is used as the pollinator, the single-cross with the male-sterile monogerm line SL 128 ms is as productive as the hybrid derived from the complex female line.

The disappointing performance of the open-pollinated monogerm variety SP 62100-0 conforms to past experience in attempts to develop an open-pollinated variety that is superior to monogerm hybrids obtained through the use of multigerm pollinators.

The determinations of clear juice purity for the regional tests were obtained through the cooperation of M. G. Frakes, Michigan Sugar Co. The procedure for the calculations of recoverable sugar from the clear juice purity is given below:

It will be observed from the tests conducted by the Northern Ohio Sugar Co. at Fremont (p. 142) and Old Fort (p. 146) that SP 5822-0 had percentage sucrose numerically below that of SP 5481-0, but the thin juice purity coefficient (p. 148) was significantly higher for SP 5822-0 in each test. This finding confirms previous indication of high quality in this multigerm variety.

A reference to the summary table on page 123 indicates that the high quality characteristic of SP 5822-0 was imparted to its hybrids. SP 5822-0 is the progenitor of SP 61151-0, which has shown combining ability for excellent quality (p. 161) when used as a pollinator.

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Standard Footnotes for all Experiments with Farmers & Manufacturers
Beet Sugar Association as Cooperator:

- a) Calculated according to Great Western formula rearranged as follows:
$$RC = TA \times 2000 \times \%S - FL \times P_K$$

RC is the calculated recoverable sugar.
TA is the yield of roots in tons per acre.
S is sucrose.
FL is factory loss (we used 0.30%)
 P_K is $1 - (MP \times 100 - CJP) / (100 - MP \times CJP)$. This factor is constant for any given clear juice purity (CJP) if the molasses purity (MP) is held constant. We used 62.5% MP for all calculations.
- b) Approximation - Calculated as percentage of difference required for significance for gross sugar on basis of relationship between general means for Gross and Recoverable sugar.
- c) Clear Juice Apparent Purity determinations were made following procedures worked out by Mr. M. G. Frakes of Michigan Sugar Co. These values approximate the thin juice purities obtained in the factory.
- d) Rating scale 0 - no evidence of disease; 10 = complete necrosis due to leaf spot.

Combined analysis, Expts. 1,3,4,5,6,&7^{1/} Year:1963

Locations: 1 in Canada, 2 in Ohio, and 3 in Michigan Expt. 16

Expt. 1 not included in Clear Juice App. Purity

Variety	Acre Yield				Roots tons	Sucrose %	Clear Juice App.(c) Purity %	Beets Leaf per Spot 100 ft. No.	
	Sugar		Gross lbs.	Recoverable lbs.					
SL128msXSP5822-0	6689	1	8023	21.77	2	18.71	90.99	1	89
SL((122X128)X126)ms XSP5822-0	6658	2	8113	22.12	1	18.52	90.59	3	94
SP62100-0	5474	6	6793	19.34	6	17.76	89.93	5	79
SL126msXSP5460-0	6154	4	7535	20.78	4	18.34	90.38	4	88
SL122msXSP5460-0	5630	3	7074	19.70	5	18.15	89.42	6	88
SP5822-0	6297	3	7658	20.93	3	18.43	90.80	2	89
General Mean	6146		7532	20.77		18.3	90.35		88
S.E. Var. Mean			128.7	.287		.16	.34		2.0
above as % Gen. Mean			1.71	1.38		0.87	0.38		2.3
LSD 5% Point	306	(b)	375	.84		.5	.98		6

Random Block Analysis				Variance Table				
				Mean Squares				
Source of Variation	D/F							Beets
		Gross	Roots	Sucrose	Purity	Leaf	100'	
		Sugar				Spot	Row	
Between Locations	5	3,269,150	45.0689	22.4077	21.2052			951
Between Varieties	5	1,621,146	7.2319	0.7048	1.7963			149
Loc. X Var.	25	99,370	0.4946	0.1565	.5723			23
Total	35							
Calculated F.value	5/25	16.31**	14.62**	4.50**	3.14*			6.48**

Standard Footnotes a), b), c), and d) on page 122.

^{1/} See pages 124-135, inclusive, for individual experiments.

AGRONOMIC EVALUATION TEST

Conducted by: C. E. Broadwell

Location: Canada & Dominion Sugar Co. Experimental Farm
Wallaceburg, Ontario

Cooperation: Canada & Dominion Sugar Co. Ltd.

Date of Planting: April 16, 1963

Date of Harvest: October 4, 1963

Experimental Design: 6 x 6 Latin Square

Size of Plots: 6 rows x 28'

Harvested Area per Plot for Root Yield: 28' x 4 center rows

Samples for Sucrose Determination: 2 samples of 10 beets each

Stand Counts: Counted when harvested

Recent Field History: 1962 - Oats
1961 - Corn
1960 - Beets

Fertilization of Beet Crop: 700# 5-20-20 with drill; 200# ammonium
nitrate broadcast & worked in before planting

Black Root Exposure: None

Leaf Spot Exposure: Very little

Other Diseases and Pests: None

Soil and Seasonal Conditions: Fairly dry

Reliability of Test: Fair - good

Cooperator: C. & D. Sugar Co.Ltd., F.&M. Beet Sugar Association Year: 1963

Location: C.&D. Wallaceburg Experimental Farm, Wallaceburg, Ontario Expt. 1

6 X 6 Latin Square

Variety	Acre Yield				Clear Juice App. Purity	Leaf Spot	Beets per 100 ft. No.
	Sugar		Gross lbs.	Roots tons			
	Recoverable lbs.	(a)					
SL128msXSP5822-0			7642 ²	22.86 ²	16.7 ³		76
SL((122X128)x126)ms XSP5822-0			7766 ¹	23.16 ¹	16.8 ²		78
SP62100-0			5722 ⁶	18.33 ⁶	15.6 ⁶		48
SL126msXSP5460-0			6912 ³	21.05 ³	16.4 ⁴		67
SL122msXSP5460-0			6672 ⁴	19.77 ⁵	16.9 ¹		71
SP5822-0			6399 ⁵	20.01 ⁴	16.0 ⁵		66
General Mean			6852	20.86	16.4		67
S.E. Var. Mean			246	.739	.224		2.5
above as % Gen. Mean			3.59	3.54	1.36		3.7
LSD 5% Point.			697	2.09	0.6		7

Latin Square Analysis			Variance Table					
Source of Variation	D/F	:	Mean Squares					
			Gross	Roots	Sucrose	Purity	Leaf	Beets
			Sugar				Spot	100' Row
Between Rows	5	:	1825490	14.4490	.6288	:	:	52
Between Columns	5	:	218538	1.1552	.5153	:	:	29
Between Varieties	5	:	3573194	21.0711	1.4787	:	:	689
Remainder (Error)	20	:	364486	3.2763	.2999	:	:	37
Total	35	:				:	:	
Calculated F. value	5/20:		9.80**	6.43**	4.93**	:	:	18.62**

Standard footnotes (a, (b, (c, and (d, page 122.

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Willard Jones farm, Ottawa, Ohio

Cooperation: F & M Beet Sugar Association, Buckeye Sugars, Inc.

Date of Planting: April 16, 1963

Date of Harvest: October 23, 1963

Experimental Design: 6 x 6 Latin Square

Size of Plots: 6 rows x 28' - 32" between rows

Harvested Area per Plot for Root Yield: 4 rows x 26 feet

Samples for Sucrose Determination: 2 samples of 10 beets each taken
consecutively from the outside
harvested rows

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1962 - Beans -(Beets were torn up) 425# 6-24-12
plus 150# 6-24-12

1961 - Alfalfa

1960 - Alfalfa - 400# 5-10-10

Fertilization of Beet Crop: 435# 6-24-12 plus Boron & Manganese

Black Root Exposure: None

Leaf Spot Exposure: Heavy

Other Diseases and Pests: Heavy Rhizoctonia - some plots

Soil and Seasonal Conditions: Dry Seedbed - Below normal moisture
throughout season

Reliability of Test: Good

Cooperator: F. & M. Beet Sugar Association, Buckeye Sugars, Inc. Year: 1963

Location: Willard Jones farm, Ottawa, Ohio Expt. 3

6 X 6 Latin Square

Variety	Acre Yield				Clear Juice		Beets	
	Sugar		Roots	Sucrose	App. Purity	Leaf Spot	per 100 ft.	No.
	Recoverable (a)	Gross						
	lbs.	lbs.	tons	%	%	(d)		
SL128msXSP5822-0	6710 2	8046	18.65 2	21.6 1	91.47 1	4.00	108	
SL((122X128)X126)ms XSP5822-0	6712 2	8098	19.30 1	21.0 2	91.24 2	3.83	111	
SP62100-0	6081 4	7530	18.08 4	20.9 4	89.88 5	2.83	104	
SL126msXSP5460-0	5729 5	7132	17.62 5	20.3 5	89.90 4	4.83	105	
SL122msXSP5460-0	5411 6	6881	17.10 6	20.1 6	89.24 6	5.17	102	
SP5822-0	6294 3	7687	18.44 3	20.9 4	90.67 3	2.00	103	
General Mean	6143	7562	18.20	20.8	90.41	3.78	105	
S.E.Var. Mean		162	.37	.22	.27	.16	2.6	
above as % Gen. Mean		2.14	2.03	1.06	0.30	4.31	2.5	
LSD 5% Point	372 (b)	458	1.05	.62	.77	.46	NS	

Latin Square Analysis				Variance Table				
				Mean Squares				
Source of Variation	D/F:	Gross Sugar	Roots	Sucrose	Purity	Leaf Spot	Beets 100'	Row
Between Rows	: 5 :	1075214	: 5.4768 :	.0838	: .6351 :	.24	: 128	
Between Columns	: 5 :	350635	: 3.4502 :	1.0976	: 1.7981 :	.18	: 41	
Between Varieties	: 5 :	1424107	: 3.6002 :	1.7452	: 4.7441 :	8.58	: 64	
Remainder (Error)	: 20 :	157496	: .8292 :	.2883	: .4450 :	.16	: 40	
Total	: 35 :							
Calculated F. value	: 5/20 :	9.04**	: 4.34** :	6.05**	: 10.66** :	53.63**	NS	

Standard footnotes (a),(b),(c, and (d, page 122.

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Arthur Busch farm, Hamler, Ohio

Cooperation: F & M Beet Sugar Association, Buckeye Sugars, Inc.

Date of Planting: April 16, 1963

Date of Harvest: October 25, 1963

Experimental Design: 6 x 6 Latin Square

Size of Plots: 6 rows x 28' - 28" between rows

Harvested Area per Plot for Root Yield: 4 rows x 26 feet

Samples for Sucrose Determination: 2 samples of 10 beets each taken
consecutively from the outside
harvested rows

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1962 - Soil Bank - No fertilizer
1961 - Oats - No fertilizer
1960 - Corn - 500# 6-24-12 82# N. Sidedressed

Fertilization of Beet Crop: 700# 6-24-12 65# N. Sidedressed

Black Root Exposure: None

Leaf Spot Exposure: Heavy

Other Diseases and Pests: Moderate Rhizoctonia - some plots

Soil and Seasonal Conditions: Dry seedbed - Below normal moisture
throughout season

Reliability of Test: Good

Cooperator: F & M Beet Sugar Association, Buckeye Sugars, Inc. Year: 1963

Location: Arthur Busch farm, Hamler, Ohio Expt. 4

6 X 6 Latin Square

Variety	Acre Yield				Clear Juice App. (c. Leaf Purity	Spot (d)	Beets Per 100 ft. No.
	Sugar		Roots tons	Sucrose %			
	Recoverable (a lbs.	Gross lbs.					
SL128msXSP5822-0	6632 2	7885	18.58 2	21.2 2	91.84 3	3.00	83
SL((122X128)X126)ms XSP5822-0	6914 1	8150	19.21 1	21.2 2	92.30 1	3.33	94
SP62100	4995 6	6230	16.04 6	19.5 6	89.81 6	2.00	71
SL126msXSP5460-0	6174 4	7559	18.49 3	20.5 4	90.57 4	3.83	79
SL122msXSP5460-0	5261 5	6598	16.71 5	19.7 5	89.84 5	4.33	80
SP5822-0	6373 3	7542	18.27 4	20.7 3	91.99 2	2.00	82
General Mean	6042	7327	17.88	20.5	91.06	3.08	82
S.E.Var. Mean		192	.41	.36	.40	.19	3.0
above as % Gen. Mean		2.62	2.29	1.73	0.44	6.20	3.7
LSD 5% Point	448 (b)	543	1.16	1.0	1.12	.54	8

Latin Square Analysis				Variance Table			
				Mean Squares			
Source of Variation	D/F	Gross Sugar	Roots	Sucrose	Purity	Leaf Spot	Beets 100' Row
Between Rows	5	2416211	12.3275	2.1615	2.4210	.32	530
Between Columns	5	744431	4.5860	.9881	.3216	.32	168
Between Varieties	5	3386645	8.9906	3.3162	7.4434	5.45	342
Remainder(Error)	20	221044	1.0097	.7582	.9422	.22	54
Total	35						
Calculated F. value	5/20	15.32**	8.90**	4.37**	7.90**	24.77**	6.33**

Standard footnotes (a),(b),(c, and (d, page 122.

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Howard Hayward farm, Bay City, Michigan

Cooperation: F & M Beet Sugar Association - Monitor Sugar Divn.

Date of Planting: April 17, 1963

Date of Harvest: October 9, 1963

Experimental Design: 6 x 6 Latin Square

Size of Plots: 6 rows x 28 feet - 28" between rows

Harvested Area per Plot for Root Yield: 4 rows x 26 feet

Samples for Sucrose Determination: 2 samples of 10 beets each taken
at random from each plot

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1962 - Potatoes - Spring plowed - 1100# 4-11-11
(Liquid)
1961 - Wheat 200# 5-20-20 250# 12-12-12 seeded to
1960 - Beans 250# 5-20-20 & Manganese (clover.

Fertilization of Beet Crop: 500# 12-12-12 plowed down (Fall); 500#
6-24-12 & Manganese at planting time
(60# N. Sidedressed

Black Root Exposure: None

Leaf Spot Exposure: light

Other Diseases and Pests: None

Soil and Seasonal Conditions: Moist seedbed - Generally good growing
conditions most of the year. Below
normal moisture latter part of season

Reliability of Test: Excellent

Cooperator: F & M Beet Sugar Association - Monitor Sugar Divn. Year: 1963

Location: Howard Hayward Farm, Bay City, Michigan Expt. 5

6 X 6 Latin Square

Variety	Acre Yield				Clear Juice		Beets per 100 ft. No.
	Sugar		Roots tons	Sucrose %	App. (o Leaf Purity % Spot		
	Recoverable (a lbs.	Gross lbs.					
SL128msXSP5822-0	6885 1	9007	26.12 2	17.3 4	88.12 4	90	
SL((122X128)X126)ms XSP5822-0	6533 4	9125	27.13 1	16.9 5	85.85 6	95	
SP62100-0	5853 6	7657	23.48 6	16.3 6	88.29 3	85	
SL126msXSP5460-0	6808 3	8689	25.00 4	17.4 2	89.11 1	95	
SL122msXSP5460-0	6140 5	8378	24.25 5	17.3 4	86.72 5	93	
SP5822-0	6856 2	8888	25.49 3	17.4 2	88.64 2	94	
General Mean	6517	8624	25.25	17.1	87.79	92	
S.E. Var. Mean		290	.89	.37	.78	2.4	
above as % Gen. Mean		3.36	3.52	2.16	0.89	2.6	
LSD 5% Point	621 (b)	822	NS	NS	NS	NS	

Latin Square Analysis				Variable Table			
				Mean Squares			
Source of Variation	D/F	Gross Sugar	Roots	Sucrose	Purity	Leaf Spot	Beets 100' Row
Between Rows	5	638008	5.6504	.1956	8.8634		162
Between Columns	5	326736	3.2034	.3467	5.7925		110
Between Varieties	5	1760762	10.2905	1.0589	9.2740		85
Remainder (Error)	20	506364	4.7042	.8178	3.6822		33
Total	35						
Calculated F. value	5/20: 3.48*		NS	NS	NS		NS

Standard footnotes (a),(b),(c, and (d, page 122.

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Harold Gremel farm, Sebewaing, Michigan

Cooperation: F & M Beet Sugar Association - Michigan Sugar Company

Date of Planting: April 18, 1963

Date of Harvest: October 17, 1963

Experimental Design: 6 x 6 Latin Square

Size of Plots: 6 rows x 28' - 28" between rows

Harvested Area per Plot for Root Yield: 4 rows x 26 feet

Samples for Sucrose Determination: 2 samples of 10 beets each
taken at random from each plot

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1962 - Beans - 300# 6-24-12 with Manganese
1961 - Corn - 300# 5-20-20
1960 - Hay, Pasture - No fertilizer

Fertilization of Beet Crop: 700# 6-24-12 with Boron and Manganese

Black Root Exposure: None

Leaf Spot Exposure: Light

Other Diseases and Pests: None

Soil and Seasonal Conditions: Moist Seedbed - Generally good growing
conditions most of the year. Below
normal moisture latter part of season

Reliability of Test: Good

Cooperator: F & M Beet Sugar Association - Michigan Sugar Company Year: 1963

Location: Harold Gremel farm, Sebewaing, Michigan Expt. 6

6 X 6 Latin Square

Variety	Acre Yield				Clear Juice App. (c Leaf Purity Spot	Beets per 100 ft. No.		
	Sugar		Roots tons	Sucrose %				
	Recoverable (a lbs.	Gross lbs.						
SL128msXSP5822-0	5954	1	7324	22.11	16.64	90.25	2	94
SL((122XL128)XL26)ms XSP5822-0	5670	2	7037	21.03	16.73	90.35	1	95
SP62100-0	4666	6	5968	18.58	16.16	89.04	5	78
SL126msXSP5460-0	5430	4	6867	20.55	16.73	89.55	4	95
SL122msXSP5460-0	4693	5	6040	18.45	16.45	88.81	6	92
SP5822-0	5615	3	7016	20.39	17.31	89.78	3	100
General Mean	5310		6708	20.18	16.6	89.63		92
S.E.Var. Mean			182	.56	.21	.36		3.7
above as % Gen Mean			2.71	2.78	1.27	0.40		4.0
LSD 5% Point	407	(b)	514	1.59	.6	1.02		10

Latin Square Analysis				Variance Table			
Source of Variation	D/F:	Mean Squares					
		Gross	Roots	Sucrose	Purity	Leaf	100'
		Sugar				Spot	Row
Between Rows	5	914110	14.2250	.7541	1.9028		111
Between Columns	5	1386949	6.8989	1.6496	2.0271		293
Between Varieties	5	1922292	12.2727	1.0385	2.5546		338
Remainder (Error)	20	198266	1.8935	.2556	.7769		82
Total	35						
Calculated F.value	5/20	9.70**	6.48**	4.06*	3.29*		4.12**

Standard footnotes (a, (b, (c, and (d, page 122.

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Fred Ruegsegger farm, Kawkawlin, Michigan

Cooperation: F & M Beet Sugar Association - Monitor Sugar Divn.

Date of Planting: April 18, 1963

Date of Harvest: October 18, 1963

Experimental Design: 6 x 6 Latin Square

Size of Plots: 6 rows x 28' - 28" between rows

Harvested Area per Plot for Root Yield: 4 rows x 26 feet

Samples for Sucrose Determination: 2 samples of 10 beets each
taken at random from each plot

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1962 - Beans - 300# 3-12-12
1961 - Wheat - Seeded to Clover - 250# 5-20-20
200# 12-12-12 Top Dressed
1960 - Beans - 300# 3-12-12

Fertilization of Beet Crop: 700# 5-20-20 65# N. Sidedressed

Black Root Exposure: None

Leaf Spot Exposure: Light

Other Diseases and Pests: None

Soil and Seasonal Conditions: Moist seedbed - Generally good
growing conditions most of the season.
Below normal moisture latter part of
season

Reliability of Test: Excellent

Cooperator: F & M Beet Sugar Association - Monitor Sugar Divn. Year: 1963

Location: Fred Ruegsegger farm. Kawkawlin, Michigan Expt. 7

6 X 6 Latin Square

Variety	Acre Yield				Clear Juice App. (c Leaf Per Purity Spot 100 ft. % % No.	
	Sugar		Roots tons	Sucrose %		
	Recoverable (a lbs.	Gross lbs.				
SL 128msXSP5822-0	7139 3	8234	22.29 3	18.5 2	93.28 1	85
SL((122X128)X126)ms XSP5822-0	7367 1	8503	22.90 2	18.6 1	93.23 2	92
SP62100-0	6539 6	7650	21.53 6	17.8 6	92.65 5	87
SL126msXSP5460-0	6886 4	8054	21.99 4	18.3 4	92.75 4	86
SL122msXSP5460-0	6714 5	7875	21.93 5	18.0 5	92.50 6	93
SP5822-0	7218 2	8419	22.96 1	18.3 4	92.93 3	87
General Mean	6955	8122	22.27	18.2	92.89	88
S.E. Var. Mean		255	.75	.24	.45	3.1
above ms % Gen. Mean		3.14	3.37	1.32	0.48	3.5
LSD 5% Point	NS	NS	NS	NS	NS	NS

Latin Square Analysis			Variance Table					
Source of Variation	:	:	Mean Squares					
	:	:						
	D/F:	:	:	:	:	:	:	Beets
	:	Gross	Roots	Sucrose	Purity	Leaf	100'	
	:	Sugar	:	:	:	Spot	Row	
Between Rows	: 5 :	429379	:1.6679 :	.7777	: .9600 :		: 96	
Between Columns	: 5 :	1502472	:6.0577 :	1.4506	: 1.7577 :		: 168	
Between Varieties	: 5 :	641020	:2.0043 :	.5550	: .4956 :		: 67	
Remainder(Error)	:20 :	389850	:3.4033 :	.3350	: 1.1976 :		: 58	
Total	:35 :		:	:	:	:	:	
Calculated F.value	:5/20:	NS	: NS :	NS	: NS :		: NS	

Standard footnotes (a),(b),(c, and (d, page 122.

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Henry Miller farm, Marlette, Michigan

Cooperation: F & M Beet Sugar Association

Date of Planting: May 9, 1963

Date of Harvest: October 10, 1963

Experimental Design: 6 x 6 Latin Square

Size of Plots: 6 rows x 28' - 28" between rows

Harvested Area per Plot for Root Yield: 4 rows x 26 feet

Samples for Sucrose Determination: 2 samples of 10 beets each taken
at random from each plot

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1962 - Pickles - 400# - 5-20-20 plus 150# 10-10-10
1961 - Pickles - 300# - 5-20-20
1960 - Corn - 300# 6-24-12 Broadcast
100# 10-10-10 banded

Fertilization of Beet Crop: 350# - 6-24-12

Black Root Exposure: None

Leaf Spot Exposure: None

Other Diseases and Pests: None

Soil and Seasonal Conditions: Moist Seedbed - Generally good growing conditions most of the year. Below normal moisture latter part of season

Reliability of Test: Excellent

Cooperator: F & M Beet Sugar Association Year: 1963

Location: Henry Miller farm, Marlette, Michigan Expt. 8

6 X 6 Latin Square

Variety	Acre Yield			Roots tons	Sucrose %	Clear Juice App. (c Leaf Purity Spot %	Beets per 100 ft. No.
	Sugar						
	Recoverable (a) lbs.	Gross lbs.					
R5651	5233 ⁶	6869	17.97 ³	19.16	88.08 ⁶	95	
SL((122X128)X126)ms	6209 ¹	7461	19.58 ¹	19.16	91.41 ¹	95	
XSP5822-0							
SP62100-0	5436 ⁵	6752	17.59 ⁴	19.24	90.13 ⁵	96	
SL126msXSP5460-0	5859 ²	7249	18.44 ²	19.71	90.23 ⁴	99	
SL122msXSP5460-0	5544 ⁴	6808	17.40 ⁶	19.63	90.52 ³	103	
SP5822-0	5677 ³	6860	17.50 ⁵	19.63	91.26 ²	99	
General Mean	5666	7000	18.08	19.4	90.27	98	
S.E. Var. Mean		204	.42	.22	1.13	2.1	
above as % Gen. Mean		2.91	2.32	1.13	1.25	2.1	
LSD 5% Point	NS	NS	1.18	NS	NS	NS	

Latin Square Analysis				Variance Table				
Source of Variation	D/F:	Mean Squares						
		Gross	Roots	Sucrose	Purity	Leaf	100'	
		Sugar				Spot	Row	
Between Rows	5	371509	4.9882	.9289	7.4113		102	
Between Columns	5	1251289	2.8245	3.0253	18.9526		162	
Between Varieties	5	490736	4.1691	.5091	8.5819		61	
Remainder (Error)	20	249504	1.0431	.2931	7.6862		27	
Total	35							
Calculated F.value	5/20:	NS	4.00*	NS	NS		NS	

Standard footnotes (a),(b),(c, and (d, page 122.

AGRONOMIC EVALUATION TEST

Conducted by: W. W. Snow

Location: Western Ontario Agricultural School, Ridgetown, Ontario

Cooperation: Canada & Dominion Sugar Co. Ltd.

Date of Planting: April 29, 1963

Date of Harvest: October 17, 1963

Experimental Design: Latin Square

Size of Plots: 4 rows x 20' x 24" between rows

Harvested Area per Plot for Root Yield: 2 rows x 16'

Samples for Sucrose Determination: 6 beets per plot

Stand Counts: All satisfactory

Recent Field History: 1962 - Oats - 600# 3-11-11
1961 - Corn - 1000# - 14-7-7

Fertilization of Beet Crop: 950# - 14-7-7

Black Root Exposure: None

Leaf Spot Exposure: None

Other Diseases and Pests: None

Soil and Seasonal Conditions: Dry Seedbed

Reliability of Test: Good

W.O.A.S.

AGRONOMIC EVALUATION TEST, SUGAR BEETS - 1963

STRAIN	TONS PER ACRE		SUGAR	PERCENTAGE	LBS. PER ACRE SUGAR
	: ROOTS YIELD	: TOPS YIELD			
SL 126 ms X SP 5460-0	: 17.56 1	: 9.70	: 21.3 1		: 7459 1
SL 128 ms X SP 5822-0	: 16.88 2	: 9.90	: 20.6 3		: 6947 3
SL [(122X128) X 126 ms] X SP 5822-0	: 16.82 3	: 9.36	: 21.2 2		: 7146 2
SP 5822-0	: 15.85 4	: 10.01	: 20.4 5		: 6494 4
SL 122 sm X SP 5460-0	: 14.91 5	: 8.74	: 20.4 5		: 6119 5
SP 62100-0	: 14.63 6	: 8.57	: 19.9 6		: 5839 6
	: :	: :	: :		: :
L.S.D. at 5% level	: 1.50	: 0.97	: :		: 73
L.S.D. at 1% level	: 2.04	: :	: :		: 100
C.V.	: 7.8%	: 8.8%	: :		: 9.1%

Planting Date - April 29

Plot Length - 20' (16' x 2 rows harvested)

Row Width = 24"

Fertilizer Amount and Analysis - 950 lbs. 14-7-7

Seed Bed Condition - Dry

Previous Crop and Fertilizer History

1962 - Oats, 3-11-11 @ 600 lbs.

1961 - Corn, 14-7-7 @ 1000 lbs.

Harvest Date - October 17

October 25, 1963

Hancock Experimental Farm
College of Agriculture
University of Wisconsin
Hancock, Wisconsin

REPORT OF 1963 SUGAR BEET TRIALS
Cooperating with Michigan State University
and USDA, ARS⁽¹⁾

Four varieties were grown under irrigated conditions on Plainfield Loamy Sand Soil at the Hancock Experimental Farm, Hancock, Wisconsin.

- Varieties: 1. SP62100-0 Monogerm, broad-base.
2. SL126 x SP5460-0 Monogerm Hybrid.
3. SL122 x SP5460-0 " "
4. SP5822-0 Multigerm (with high Cercospora resistance.)

Soil Test--P- 165 lbs./acre; K- 185 lbs./acre; pH - 6.5.

Planted--4/26/63 with belt seeder. Row width 28" - seed dropped approximately at 1" intervals, about 1" average depth.

Fertilizer applied--

4/26/63 Broadcast pre-plant - 550 lbs./acre 0-0-60.

Banded in row 3" deep, 165#/acre 8-16-16.

Side dressed applications--

6/11/63 - 250 lbs./acre 33-0-0.

7/9/63 - 300 lbs./acre 33-0-0 plus 10#/acre Borax.

Weed Control--

4/26/63 - Broadcast pre-plant 3 lbs./acre Tillam.⁽²⁾ Disked in.

6/6/63 - Thinned to 12 to 15 plants in 10 feet.

7/9/63 - Hoed and hand weeded.

Harvested Oct. 21, 1963.

Sucrose Analysis - Oct. 24, 1963, by the American Crystal Sugar Co., Chaska, Minnesota⁽³⁾ (15 beets per plot were sampled.)

1963 Sugar Beets, Hancock, Wisconsin. Yield in Tons per acre.
Replicate

Treatment	I	II	III	IV	V	VI	T	Ave 6 reps.
SP62100-0	25.0	25.9	34.2	24.1	25.3	29.0	163.5 3	27.2
SL126 x SP5460-0	29.8	30.3	30.4	27.8	26.9	25.6	170.8 1	28.5
SL122 x SP5460-0	31.6	25.7	27.9	26.7	26.8	26.4	165.1 2	27.5
SP5822-0	30.4	26.2	25.0	24.0	27.8	27.4	160.8 4	26.8

(1) George J. Hogaboam, Research Agronomist, USDA, ARS.

(2) Tillam furnished by Stauffer Chemical Company.

(3) D. R. Peterson, Plant Superintendent.

1963 Sugar Beet Trials, Hancock Wisconsin

Sugar Beet Sucrose Analysis - Per Cent Sucrose.
Replicate

<u>Treatment</u>	<u>I</u>	<u>II</u>	<u>III</u>	<u>IV</u>	<u>V</u>	<u>VI</u>	<u>Total</u>	<u>Ave. 6 reps.</u>
SP62100-0	17.5	17.4	18.0	18.5	18.4	17.7	107.5	4 17.9
SL126 x SP5460-0	18.3	19.6	18.3	18.4	17.8	18.4	110.8	1 18.5
SL122 x SP5460-0	18.0	18.2	18.1	18.4	18.5	17.6	108.8	3 18.1
SP5822-0	18.2	18.4	16.7	18.6	18.7	18.3	108.9	3 18.2

Irrigation Applied:

Date

Inches per acre

6/3	1.3
6/25	1.3
6/29	1.3
7/2	1.3
7/6	1.3
7/11	1.3
7/17	1.3
7/25	1.3
7/31	1.3
8/7	1.3
8/16	1.3
9/19	1.5
12 applications	-- 15.8 inches per acre total.

5/7/63 - Severe sand storm wind damaged and buried by drifting sand, plants in Reps. I, II and III.

Diseases - no evidence of Cercoospora. Rhizoctonia damage to scattered plants first noted on 7/22/63. Damage actually was not as great as it first appeared that it would be. No differences were noted between varieties as to degree of infestation.

Myron D. Groskopp, Supt.
Hancock Experimental Farm

AGRONOMIC EVALUATION TEST, 1963

General Variety Test

Conducted by: Richard Zielke, H. L. Bush, R. K. Oldemeyer, and D. L. Sunderland

Location: Glenn Haas Farm, Fremont, Ohio

Cooperation: Northern Ohio Sugar Company

Date of Planting: April 27, 1963

Date of Harvest: October 14, 1963

Experimental Design: Triple Lattice

Size of Plots: 4 rows x 24 feet planted (28-inch rows)

Harvest Area per Plot for Root Yield: 4 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand Counts and Bolter Counts: Beets counted in laboratory for harvest stand.
No bolters developed.

Recent Field History: Corn (1962)

Fertilization of Beet Crop: 400 pounds 0-25-25 plowed down
116 pounds N as anhydrous ammonia sidedressed on June 17
200 pounds 6-24-12 in row

Leaf Spot Exposure: Very light, late development

Black Root Exposure: Mild

Curly Top Exposure: None noted

Other Diseases: None noted

Soil and Seasonal Conditions: Good soil moisture conditions existed shortly after planting. Remainder of the summer was extremely dry.

Cooperator: Northern Ohio Sugar Company by Richard Zielke, H. L. Bush,
R. K. Oldemeyer and D. L. Sunderland

General Variety Test

Location: Glen Haas Farm, Fremont, Ohio

Year: 1963

(Results given as 12 plot averages)

Variety	Acre Yield				Thin Juice App. Purity (%)	Leaf ^(d) Spot (10/5/63)	Beets ^(e) per 100 ft. (No.)
	Recover-able ^(a) (lbs.)	Gross Sugar (lbs.)	Roots (tons)	Sucrose (%)			
SP5822-0	5676 ¹	6309	15.51 ¹	20.34 ³	95.06 ¹	0.2	144
SP5481-0	5575 ²	6280	15.43 ²	20.35 ³	94.41 ²	0.3	150
SP62100-0	4859 ³	5580	13.69 ³	20.38 ³	93.50 ³	0.0	143
General Mean ^(f)	5354	6054	14.81	20.44	94.23	0.3	142
S.E. Variety Mean (Sm)	-	344.11	1.9294	.0933	.1923	-	-
Sm/Gen. Mean (%)	-	1.64	1.58	0.46	0.20	-	-
LSD 5% pt.	254 ^(b)	287	0.67	0.27	0.55	-	-

Variance Table^(c)

Source of Variance	DF	Mean Squares		
		Roots (lbs.) ^(h)	Sucrose (%)	Purity (%)
Replicates	11	164.3109	.3018	.7264
Component (a)	18	49.3128	.1172	.4322
Component (b)	6	30.5950	.1067	.4433
Blocks (eliminating varieties)	24	44.6333	.1146	.4350
Varieties (ignoring blocks)	8	1813.2300	1.2100	7.8163
Error (Intra-block)	64	44.6817	.1008	.4470
Error (Random Block)	88	44.6685 ^(g)	.1045 ^(g)	.4438 ^(g)
Total	107	189.1971	.2075	1.0240
Calculated F value		40.59**	11.58**	17.61**

(a, (b, (c) See page 1148.

(d) 0 = no evidence of disease, 10 = complete necrosis due to leaf spot

(e) Harvest stand

(f) General mean for 9 varieties in test

(g) Error term used

(h) Pounds per plot

AGRONOMIC EVALUATION TEST, 1963

General Variety Test

Conducted by: Richard Zielke, H. L. Bush, R. K. Oldemeyer, and D. L. Sunderland

Location: Kenneth Krauss Farm, Findlay, Ohio

Cooperation: Northern Ohio Sugar Company

Date of Planting: April 18, 1963

Date of Harvest: October 2, 1963

Experimental Design: Triple Lattice

Size of Plots: 4 rows x 22 feet planted (22-inch rows)

Harvest Area Per Plot for Root Yield: 4 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand Counts and Bolter Counts: Beets counted in laboratory for harvest stand.
No bolters developed.

Recent Field History: Corn (1962)

Fertilization of Beet Crop: 100 pounds N, 180 pounds P_2O_5 and 120 pounds K_2O
plowed down.
150 pounds 6-24-12 in row.

Leaf Spot Exposure: Mild, late development

Black Root Exposure: Mild

Curly Top Exposure: None noted

Other Diseases: Rhizoctonia crown rot caused slight loss in stands.

Soil and Seasonal Conditions: Extremely dry weather was encountered throughout the growing season.

Cooperator: Northern Ohio Sugar Company by Richard Zielke, H. L. Bush,
R. K. Oldemeyer and D. L. Sunderland

General Variety Test

Location: Kenneth Krauss Farm, Findlay, Ohio

Year: 1963

(Results given as 12 plot averages)

Variety	Acre Yield				Thin		
	Sugar				Juice App. Purity	Leaf ^(d) Spot	Beets ^(e) per 100 ft.
	Recover- able ^(a) (lbs.)	Gross (lbs.)	Roots (tons)	Sucrose (%)			
SP5481-0	5916 ¹	6842	16.50 ¹	20.73 ³	93.17 ³	0.8	170
SP5822-0	5749 ²	6508	15.42 ²	21.10 ¹	94.17 ¹	0.3	169
SP62100-0	5185 ³	5991	14.29 ³	20.96 ²	93.22 ³	0.6	148
General Mean ^(f)	5677	6577	15.71	20.95	93.09	0.9	156
S.E. Variety Mean (Sm)	-	167.69	3.2767	.1523	.3646	-	-
Sm/Gen. Mean (%)	-	2.55	2.43	0.76	0.39	-	-
LSD 5% pt.	418 ^(b)	4.84	1.10	0.46	1.05	-	-

Variance Table^(c)

Source of Variance	DF	Roots (lbs.) ^(h)	Sucrose (%)	Purity (%)
Replicates	11	920.1409	2.7091	7.0582
Component (a)	18	62.7839	.3500	.9550
Component (b)	6	72.9517	.4733	.9417
Blocks (eliminating varieties)	24	65.3258	.3808	.9517
Varieties (ignoring blocks)	8	1211.2025	1.6788	10.4975
Error (Intra-block)	64	64.1023	.2781 ^(g)	1.8369
Error (Random Block)	88	64.4360 ^(g)	.3061	1.5955 ^(g)
Total	107	238.1452	.6558	2.8226
Calculated F value		18.80*	5.48*	6.58*

(a, (b, (c See page 118.

(d 0 = no evidence of disease, 10 = complete necrosis due to leaf spot

(e Harvest stand

(f General mean for 9 varieties in test

(g Error term used

(h Pounds per plot

AGRONOMIC EVALUATION TEST, 1963

General Variety Test

Conducted by: Richard Zielke, H. L. Bush, R. K. Oldemeyer, and D. L. Sunderland

Location: George Riehm Farm, Old Fort, Ohio

Cooperation: Northern Ohio Sugar Company

Date of Planting: April 17, 1963

Date of Harvest: November 1, 1963

Experimental Design: Triple Lattice

Size of Plots: 4 rows x 24 feet planted (28-inch rows)

Harvest Area per Plot for Root Yield: 4 rows x 18 feet

Samples for Sucrose Determinations: 2 samples per plot, each 1 row x 18 feet

Stand Counts and Bolter Counts: Beets counted in laboratory for harvest stand.
No bolters developed.

Recent Field History: Tomatoes (1962)

Fertilization of Beet Crop: 100 pounds N
80 pounds P₂O₅ } Broadcast and plowed down
255 pounds K₂O }
150 pounds 6-24-12 in row

Leaf Spot Exposure: Moderate, September development

Black Root Exposure: Mild

Curly Top Exposure: None noted

Other Diseases: Rhizoctonia crown rot caused loss in stands

Soil and Seasonal Conditions: Extremely dry weather conditions persisted all summer. Light showers were received in September. Good soil moisture conditions existed shortly after planting.

Cooperator: Northern Ohio Sugar Company by Richard Zielke, H. L. Bush,
R. K. Oldemeyer and D. L. Sunderland
General Variety Test
 Location: George Riehm Farm, Old Fort, Ohio Year: 1963

(Results given as 12 plot averages)

Variety	Acre Yield				Thin Juice App.		Beets per 100 ft.	
	Recover- able ^(a) (lbs.)	Gross (lbs.)	Roots (tons)	Sucrose (%)	Purity (%)	Leaf Spot ^(d) (9/7/63)(10/26/63)		
SP5822-0	7898 1	8839	23.29 1	18.97 3	94.78 1	0.3	0.8	134
SP5481-0	7604 2	8671	22.79 2	19.02 2	93.89 2	1.1	2.1	152
SP62100-0	6358 3	7373	19.11 3	19.28 1	93.08 3	0.2	0.8	140
General Mean ^(f)	7177	8247	21.66	19.01	93.53	0.9	1.7	139
S.E. Variety Mean (Sm)	-	184.38	3.4505	.1648	.1959	-	-	-
Sm/Gen. Mean (%)	-	2.23	2.06	0.87	0.21	-	-	-
LSD 5% pt.	463	532	1.29	0.48	0.57	-	-	-

Variance Table^(c)

Source of Variance	DF	Mean Squares		
		Roots (lbs.) ^(h)	Sucrose (%)	Purity (%)
Replicates	11	87.0682	.9936	5.3018
Component (a)	18	133.5606	.3511	.4206
Component (b)	6	129.3100	.1467	.3350
Blocks (eliminating varieties)	24	132.4979	.3000	.3992
Varieties (ignoring blocks)	8	5592.0612	2.2125	15.5500
Error (Intra-block)	64	146.0788	.3356	.4833
Error (Random Block)	88	142.3749 ^(g)	.3259 ^(g)	.4603 ^(g)
Total	107	544.1423	.5356	2.0863
Calculated F value		39.28**	6.79**	33.78**

(a, (b, (c See page 148.

(d 0 = no evidence of disease, 10 = complete necrosis due to leaf spot

(e Harvest stand

(f General mean for 9 varieties in test

(g Error term used

(h Pounds per plot

(a) Recoverable Sugar

A technique, whereby thin juice purity could be determined from small samples, was first used in 1953, following methods developed in the G. W. Research Laboratory at Denver. Using the resultant purity figure, a calculated "Recoverable Sugar" is obtained. An example of the calculation is as follows:

Sugar in beets = 12.00%
 Standard total losses = 0.30%
 Sugar on beets at sugar end = 12.00 - 0.30 = 11.70%

Assume standard molasses purity = 62.5%
 100.0 - 62.5 = 37.5% Impurities on solids in molasses

$\frac{62.5}{37.5} = 1.6667\%$ Sugar on impurities in molasses

Sugar sacked
 85% purity thin juice = 15% impurities
 $\frac{15}{85} = 17.6471\%$ impurities on sugar

Sugar end = 11.70 + 17.6471% = 2.06471% on beets
 Molasses produced = 2.06471 x 1.66667 = 3.4413% on beets
 Sugar sacked = 12.00 - (0.30 + 3.4413) = 8.2587%

Recoverable sugar = $\frac{8.2587}{12.00} = 68.82\%$

(b) Approximation - Calculated as percentage of "difference required for significance for "gross" sugar on basis of relationship between general means for "Gross" and "Recoverable" sugar.

(c) Gross sugar calculated from the formula:

$$S \text{ lbs. sugar} = \text{Mean lbs. sugar} \sqrt{\left(\frac{S \text{ lbs. beets}}{\text{Mean lbs. beets}}\right)^2 + \left(\frac{S \% \text{ sugar}}{\text{Mean \% sugar}}\right)^2}$$

Section 2. Evaluations of Breeder Seed, Inbred Lines, and
Experimental Hybrids

The need for further improvement in monogerm varieties and hybrids in the Great Lakes region impels a continuing search for suitable and more desirable basic breeding material. Several centers of sugarbeet breeding (mostly U.S. Department of Agriculture) have made available entries for evaluations. Most of the breeding material was developed by G. E. Coe or supplied from other sources through the Farmers & Manufacturers Beet Sugar Association.

The tests at Ft. Jennings, Ohio, and Merrill, Michigan, were conducted by M. R. Berrett, F. & M, with clear juice purity determination by M. G. Frakes, Michigan Sugar Co. (p. 122), and analysis of variances by G. J. Hogaboam. Tests at Fremont and Old Fort, Ohio, were the full responsibility of the Northern Ohio Sugar Co. The descriptions of the various entries in the several tests are given on page 151. The results of individual tests are given on pages 152-160.

Results: The multigerm variety SP 5822-0, which occurs as an entry in all of these tests as well as in tests given in Section 1 (p. 121), may be taken as a standard for judging relative performances of the entries. The multigerm variety SP 5481-0, which occurs in the Ft. Jennings and Merrill tests (p. 160), is related to and essentially equivalent in productivity to US 401, a multigerm variety formerly used in the region. In these tests the average performances of SP 5822-0 and SP 5481-0 were very similar, except that SP 5822-0 was more resistant to leaf spot.

The field tests of the Northern Ohio Sugar Co. (p. 152) confirm the excellent quality (thin juice purity) of SP 5822-0. It will be noted that SP 6122-0 and SP 61151-0, which have been derived from SP 5822-0, show the excellent quality of their progenitor. Thus with the same quantity of gross sugar per ton of roots these high quality varieties would give higher sugar recovery than varieties of lower quality. The progenitive tendency of the excellent quality characteristic of SP 5822-0 and SP 61151-0 has been mentioned in Sections 1 and 3 of this report.

The purity coefficients of hybrids 62B1 X 05 and 62B2 X 05, which have EL 32C1 as the female parent but SP 5822-0 and 02 clone, respectively, as pollinators, indicate that the 02 clone also is an excellent pollinator.

SP 5944-0, which was derived from a Russian monogerm variety (p. 389), was hybridized with American monogerm lines to produce the three hybrids SP 623359-02, -010, and -012. In the tests conducted by the Northern Ohio Sugar Co. (p. 152), these hybrids were intermediate in productivity. In the Merrill test (p. 156), the -012 hybrid produced the highest yield of roots and gross sugar of the 36 entries.

The line SP 623000-0, which derived its monogermness from an accession of Beta maritima (p. 384), was hybridized with three monogerm lines to produce

hybrids SP 623000-02, -011, and -013. The root yield and sugar production of these hybrids in the Merrill test were significantly lower than for the commercial hybrid SL 126ms X SP 5460-0, but in the Ft. Jennings test (p.158) the hybrids SP 623000-011 and -013 did not differ significantly from the commercial check in these categories of comparison. The maritima hybrids were more resistant to leaf spot than the check.

The entries in these tests provide certain comparisons between diploid and triploid hybrids. In the summary of the F & M tests (p.160), the triploid hybrid SP 623356-04 ranks highest in gross sugar production, but other triploid hybrids do not rank so favorably. For example, the triploid hybrid F 61-562HO X US 401 (4n) ranks 13th in the list of 36 and has gross sugar production numerically below that of SP 5481-0 or SP 5822-0.

In general, these tests serve to give preliminary indication of breeding material of superior potentialities for the region, but further hybridizations and evaluations are required before utilization of specific entries or hybrid combinations of parental material is recommended.

DESCRIPTION OF LINES IN MISCELLANEOUS FIELD TRIALS OF 1963

Monogerm male-sterile lines used in the production of hybrids:

SL 122ms - resistant to curly top.
SL 126ms - do.
SL 128ms - do.
SL 129ms - do.
SL 133ms - do.
SL (122 X 127)128)129)ms - resistant to curly top.
CT5 mm ms - resistant to curly top.
F60-569HO - resistant to curly top and bolting.
F61562 - inbred; resistant to curly top and bolting.
(AI-10 X AI-12) - furnished by Amalgamated Sugar Co.
SP 6223-0X - male sterile or F₁ male sterile with some resistance to leaf spot and black root.
SP 6224-0X - do.
SP 6225-0X - do.
SP 557ms - do. (Isolated and supplied by U-I Sugar Co.)

Pollen-fertile lines used in the production of monogerm hybrids:

6045 sel - Utah-Idaho selection from LSR-BRR monogerm synthetic.
UI 160 - pollen-fertile line of U-I Sugar Co.
SL 010 - selection for curly top resistance from US 201B multigerm.
SL 0410 - differs from SL 010 only in number of Mendelian male-sterile segregants.
02 Clone - multigerm; resistant to leaf spot and black root.
US 401 4n - US 401 tetraploidized by Helen Savitsky.
SP 5460-0 - multigerm; leaf spot and black root resistant.
SP 6180-0 - multigerm synthetic, leaf spot and black root resistant.
SP 5822-0 - multigerm synthetic with good resistance to leaf spot and tolerant to black root.
SP 6122-0 - multigerm selected from SP 5822-0 for yield and leaf spot resistance.
SP 61151-0 - multigerm selected from SP 5822-0 for purity and leaf spot resistance.
SP 6256-0 - multigerm synthetic resistant to leaf spot and black root.
62B25-0 - selection from US 401 multigerm by H. L. Kohls.
62B26-0 - leaf spot resistant multigerm selection by H. L. Kohls.

Other varieties in the tests:

SP 62100-014 - open-pollinated monogerm; leaf spot and black root resistant.
SP 62100-030 - do.
SP 62100-055 - do.
SP 62100-0 - pooled seed of the above and other similarly related lines.
62B1X05 - monogerm hybrid EL32C₁ X 02 clone (see above).
62B2X05 - monogerm hybrid EL32C₁ X SP 5822-0 (see above).
62B1X09 - monogerm hybrid SP 6123-01 X 02 clone (see above).
R 5651 - monogerm hybrid furnished by U-I Sugar Co.
SP 603000-0 - open-pollinated pollen-fertile monogerm derived from B.maritima source.
SP 623000-02 - monogerm hybrid SP 6020-05mmMS X SP 603000-0 (described above).
SP 623000-011- monogerm hybrid SP 601152H01mmMS X SP 603000-0 (described above).
SP 623000-013- monogerm hybrid SP 601159H01mmMS X SP 603000-0 (described above).
SP 603102-0 - tetraploid pollen-fertile multigerm resistant to leaf spot and black root.
SP 603107-0 - tetraploid pollen-fertile multigerm resistant to leaf spot and black root.
SP 623356-04 - triploid monogerm hybrid SP 6123-01mmMS X SP 603102-0 (described above).
SP 623356-05 - triploid monogerm hybrid SP 6124-01mmMS X SP 603102-0 (described above).
SP 623357-013- triploid monogerm hybrid SP 601159H01mmMS X SP 603103-01 4n MM PF resistant to leaf spot and black root.
SP 623358-04 - triploid monogerm hybrid SP 6123-01mmMS X SP 603107-0 (described above).
SP 623358-07 - triploid monogerm hybrid SP 6125-01mmMS X SP 603107-0 (described above).
SP 5944-0 - open-pollinated monogerm (Russian source) selected for tolerance to leaf spot.
SP 623359-02 - monogerm hybrid SP 6020-03mmMS X SP 5944-0mm PF (described above).
SP 623359-010- monogerm hybrid FC 502CMSmm X SP 5944-0mm PF (described above).
SP 623359-012- monogerm hybrid SP 601158H01mmMS X SP 5944-0mm PF (described above).
SP 623360-010- monogerm hybrid FC 502CMSmm X SP 6061-0mm PF synthetic variety in field trials in 1961.

AGRONOMIC EVALUATION TEST, 1963

Miscellaneous Variety Test

Conducted by: Richard Zielke, H. L. Bush, R. K. Oldemeyer and D. L. Sunderland

Location: Glenn Haas Farm, Fremont, Ohio

Cooperation: Northern Ohio Sugar Company

Date of Planting: April 26, 1963

Date of Harvest: October 7, 1963

Experimental Design: Triple Lattice

Size of Plots: 1 row x 24 feet planted (28-inch rows)

Harvest Area per Plot for Root Yield: 1 row x 18 feet

Samples for Sucrose Determinations: 1 sample per plot; 1 row x 18 feet

Stand Counts and Bolter Counts: Beets counted in laboratory for harvest stand.
No bolters developed.

Recent Field History: Corn (1962)

Fertilization of Beet Crop: 400 pounds 0-25-25 plowed down
116 pounds N as anhydrous ammonia sidedressed on June 17
200 pounds 6-24-12 in row

Leaf Spot Exposure: Mild, late development

Black Root Exposure: Mild to moderate

Curly Top Exposure: None noted

Other Diseases: None noted

Soil and Seasonal Conditions: Extremely dry weather throughout the summer.
Favorable moisture conditions did exist during the seedling stage.

Cooperator: Northern Ohio Sugar Company by Richard Zielke, H. L. Bush,
R. K. Oldemeyer and D. L. Sunderland

Miscellaneous Variety Test

Location: Fremont, Ohio Year: 1963
 (Results given as 12 plot averages)

Variety	Acre Yield				Thin Juice App. Purity (%)	Leaf ^(d) Spot (10/4/63)	Beets ^(e) per 100 ft. (No.)
	Recover-able ^(a) (lbs.)	Gross Sugar (lbs.)	Roots (tons)	Sucrose (%)			
62B2 x 05	6223 ¹	7178	18.52 ¹	19.38 ¹⁵	93.32 ¹³	0.8	126
62B1 x 05	5947 ²	6832	17.42 ³	19.61 ¹¹	93.51 ⁸	1.2	137
SP623356-04	5942 ³	6852	17.01 ⁶	20.14 ⁴	93.31 ¹³	0.7	112
SP623356-05	5919 ⁴	6894	17.56 ²	19.63 ¹⁰	92.88 ¹⁷	0.6	117
SP623358-04	5892 ⁵	6790	17.12 ⁴	19.83 ⁸	93.34 ¹³	0.9	106
SP623358-07	5726 ⁶	6648	17.10 ⁵	19.44 ¹²	93.02 ¹⁵	0.8	98
62B1 x 09	5539 ⁷	6255	15.52 ¹⁰	20.15 ⁴	94.29 ⁵	1.2	113
SP623359-02	5482 ⁸	6439	16.62 ⁷	19.37 ¹⁶	92.50 ¹⁸	1.5	103
SP623359-010	5455 ⁹	6277	15.85 ⁹	19.80 ⁹	93.41 ¹⁰	0.6	100
SP623359-012	5430 ¹⁰	6321	16.47 ⁸	19.19 ¹⁷	92.93 ¹⁶	1.2	106
SP6122-0	5090 ¹¹	5716	14.34 ¹²	19.93 ⁷	94.56 ⁴	0.0	120
SP6256-0	5010 ¹²	5616	14.46 ¹¹	19.42 ¹³	94.68 ³	0.3	142
SP61151-0	4959 ¹³	5520	13.57 ¹⁵	20.34 ¹	94.99 ²	0.0	126
SP5822-0	4927 ¹⁴	5472	13.64 ¹⁴	20.06 ⁵	95.10 ¹	0.2	119
SP6180-0	4606 ¹⁵	5251	13.54 ¹⁶	19.39 ¹⁴	93.87 ⁶	0.3	119
SP623000-02	4555 ¹⁶	5243	13.76 ¹³	19.05 ¹⁸	93.43 ¹⁰	1.5	118
SP623000-013	4266 ¹⁷	4895	12.25 ¹⁷	19.98 ⁶	93.53 ⁸	0.9	115
SP623000-011	3917 ¹⁸	4546	11.23 ¹⁸	20.24 ²	93.01 ¹⁵	0.7	111
General Mean ^(f)	4897	5632	14.13	19.93	93.43	0.6	116
S.E. Variety Mean (Sm)	-	237.05	1.1992	.1828	.3359	-	-
Sm/Gen. Mean (%)	-	4.21	4.11	0.92	0.36	-	-
LSD 5% pt.	601 ^(b)	691	1.69	0.54	0.90	-	-

Variance Table^(c)

Source of Variance	DF	Mean Squares		
		Roots (lbs.) ^(h)	Sucrose (%)	Purity (%)
Replicates	11	18.8136	1.5382	6.8700
Component (a)	45	39.8558	1.3718	2.5244
Component (b)	15	32.4507	.6900	1.6193
Blocks (eliminating varieties)	60	38.0045	1.2013	2.2982
Varieties (ignoring blocks)	35	250.6897	2.4360	5.3194
Error (Intra-block)	325	17.2571 ^(g)	.4008 ^(g)	1.3537 ^(g)
Error (Random Block)	385	20.4905	.5256	1.5009
Total	431	39.1413	.7065	1.9480
Calculated F Value		14.53**	6.08**	3.93**

(a, (b, (c See page 148.

(d 0 = no evidence of disease, 10 = complete necrosis due to leaf spot

(e Harvest stand

(f General mean for 36 varieties in test

(g Error term used

(h Pounds per plot

AGRONOMIC EVALUATION TEST, 1963

Miscellaneous Variety Test

Conducted by: Richard Zielke, H. L. Bush, R. K. Oldemeyer and D. L. Sunderland

Location: George Riehm Farm, Old Fort, Ohio

Cooperation: Northern Ohio Sugar Company

Date of Planting: April 16, 1963

Date of Harvest: November 1, 1963

Experimental Design: Triple Lattice, 12 replicates

Size of Plots: 1 row x 24 feet planted (28-inch rows)

Harvest Area per Plot for Root Yield: 1 row x 18 feet

Samples for Sucrose Determinations: 1 sample per plot, 1 row x 18 feet

Stand Counts and Bolter Counts: Beets counted in the laboratory for harvest stand. No bolters developed.

Recent Field History: Tomatoes (1962)

Fertilization of Beet Crop: 100 pounds N, 80 pounds P_2O_5 and 255 pounds K_2O
plowed down.
150 pounds 6-24-12 in row.

Leaf Spot Exposure: Moderate, September development

Black Root Exposure: Mild

Curly Top Exposure: None noted

Other Diseases: Rhizoctonia crown rot caused some loss in stands.

Soil and Seasonal Conditions: Extremely dry weather prevailed through the summer. Adequate moisture was received for the germination and seedling stages of growth.

Cooperator: Northern Ohio Sugar Company by Richard Zielke, H. L. Bush,
R. K. Oldemeyer and D. L. Sunderland

Miscellaneous Variety Test

Location: Old Fort, Ohio

Year: 1963

(Results given as 12 plot averages)

Variety	Acre Yield				Thin		
	Recover- able ^(a) (lbs.)	Gross (lbs.)	Roots (tons)	Sucrose (%)	Juice App. Purity (%)	Leaf ^(d) Spot (10/26/63)	Beets ^(e) per 100 ft. (No.)
SP623358-04	9948 ¹	11495	30.23 ¹	19.01 ⁴	93.27 ⁶	1.6	114
SP623356-05	9475 ²	11097	30.06 ²	18.46 ¹⁴	92.69 ¹⁰	0.9	126
62B1 x 09	9179 ³	10531	27.37 ⁶	19.24 ¹	93.60 ⁵	2.1	119
SP623356-04	9090 ⁴	10568	28.18 ³	18.75 ⁶	92.99 ⁸	1.3	114
62B2 x 05	8859 ⁵	10250	27.57 ⁵	18.59 ¹²	93.24 ⁷	1.4	130
62B1 x 05	8675 ⁶	10209	27.01 ⁸	18.90 ⁵	92.45 ¹³	2.0	146
SP623358-07	8503 ⁷	10127	27.59 ⁵	18.35 ¹⁶	91.95 ¹⁵	1.4	106
SP623359-012	8456 ⁸	10073	26.90 ⁹	18.72 ⁷	91.95 ¹⁵	2.3	112
SP623359-010	8405 ⁹	9865	25.78 ¹⁰	19.13 ²	92.57 ¹¹	1.9	117
SP6122-0	8338 ¹⁰	9431	24.70 ¹⁴	19.09 ³	94.27 ²	0.8	132
SP61151-0	8332 ¹¹	9431	25.16 ¹³	18.74 ⁸	94.27 ²	0.8	135
SP5822-0	8270 ¹²	9460	25.24 ¹¹	18.74 ⁸	93.77 ³	0.7	138
SP623359-02	8139 ¹³	9873	27.07 ⁸	18.24 ¹⁷	91.20 ¹⁸	2.8	117
SP6180-0	8012 ¹⁴	9358	25.14 ¹³	18.61 ¹¹	92.81 ⁹	0.6	145
SP6256-0	7890 ¹⁵	9057	24.57 ¹⁵	18.43 ¹⁵	93.61 ⁵	0.5	154
SP623000-011	7214 ¹⁶	8817	23.69 ¹⁶	18.61 ¹¹	90.86 ¹⁶	1.5	117
SP623000-013	7085 ¹⁷	8331	22.49 ¹⁷	18.52 ¹³	92.51 ¹²	1.5	124
SP623000-02	6276 ¹⁸	7548	21.11 ¹⁸	17.88 ¹⁸	91.75 ¹⁷	1.7	104
General Mean ^(f)	7697	9054	24.08	18.81	92.47	1.3	130
S.E. Variety Mean (Sm)	-	326.96	1.6020	.2007	.3853	-	-
Sm/Gen. Mean (%)	-	3.61	3.45	1.07	0.42	-	-
LSD 5% pt.	770 ^(b)	906	2.30	0.56	1.07	-	-

Variance Table^(c)

Source of Variance	DF	Mean Squares		
		Roots (lbs.) ^(h)	Sucrose (%)	Purity (%)
Replicates	11	101.5482	1.5500	13.9909
Component (a)	45	22.7136	.5784	1.5987
Component (b)	15	28.3927	.9353	2.1107
Blocks (eliminating varieties)	60	24.1333	.6677	1.7267
Varieties (ignoring blocks)	35	578.6731	2.2391	11.4683
Error (Intra-block)	325	32.0274	.4491	1.7916
Error (Random Block)	385	30.7972 ^(g)	.4832 ^(g)	1.7815 ^(g)
Total	431	77.0940	.6530	2.8797
Calculated F Value		18.79**	4.63**	6.44**

(a, (b, (c See page 1148.

(d 0 = no evidence of disease, 10 = complete necrosis due to leaf spot

(e Harvest stand

(f General mean for 36 varieties in test

(g Error term used

(h Pounds per plot

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Detroit Stake Farm, Merrill, Michigan

Cooperation: F & M Beet Sugar Association - Michigan Sugar Company

Date of Planting: April 13, 1963

Date of Harvest: October 1, 1963

Experimental Design: 6 x 6 Triple Lattice

Size of Plots: 6 rows x 20' - 30" between rows

Harvested Area per Plot for Root Yield: 4 rows x 18'

Samples for Sucrose Determination: 2 samples of 6 beets each taken
consecutively from the outside
harvested rows

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1962 - Corn - 400# 6-24-12
1961 - Corn - 400# 6-24-12
1960 - Beets - 500# 6-24-12

Fertilization of Beet Crop: 400# 5-20-20 broadcast; 300# 10-20-10 plus
Boron and Manganese at planting time

Black Root Exposure: None

Leaf Spot Exposure: None

Other Diseases and Pests: None

Soil and Seasonal Conditions: Moist Seedbed - Generally good growing
conditions most of the year. Below
normal moisture latter part of season

Reliability of Test: Good

Cooperator: F. & M. Beet Sugar Assn., Michigan Sugar Company

Year: 1963

Location: Detroit Stake Farm, Merrill, Michigan

Expt.: 11

6 X 6 triple lattice analyzed as a random block

	Acre yield			Roots	Sucrose	Clear Juice		Leaf Spot	Beets per 100'
	Sugar (a)		App. (c)			Purity			
	Recoverable	Gross							
	lbs.	lbs.	tons	%	%				
SL133 X SP5460-0	5046	7890	23.27	16.99	82.77			80	
CT5 X SP5460-0	5397	8006	23.74	16.81	84.27			93	
SL(122X127)(128)(129)msXUI160	5883	8164	23.74	17.33	86.01	14	-	95	
SL128 X SP6045sel.	5422	7420	22.35	16.61	86.69	9		94	
SL128 X SLO10	5691	7890	21.96	18.01	86.15	12	-	91	
SL129 X SLO10	4981	7622	22.47	17.06	83.21			91	
SL128 X SLO410	4865	7375	21.08	17.52	83.51			96	
R5651	5390	7451	21.88	17.05	86.39	11		75	
(AI-10XAI-12)msXUS401 4n	5085	7107	21.92	16.2	86.08	13	-	88	
SP557ms X US401 4n	5251	7141	21.40	16.71	86.87	7		84	
F60-569HO X US401 4n	5072	7492	22.93	16.3	84.37			75	
F61-562HO X US401 4n	5104	7448	23.66	15.8	84.57			78	
SL126ms X US 401 4n	4959	7433	22.97	16.1	84.03			83	
SL122ms X US401 4n	5341	7014	21.34	16.4	88.21	1		86	
F61-562 X SP5460-0	4817	7127	22.41	15.9	84.27			87	
(AI-10XAI-12)msXSP5460-0	5715	7496	22.53	16.71	88.03	3		89	
SP557ms X SP5460-0	5181	6967	21.58	16.2	87.18	5		87	
SP62100-030	5417	7179	21.70	16.51	87.89	4		93	
SP62100-011	5032	7401	23.50	15.7	84.54			79	
EP62100-055	5134	7281	23.09	15.8	85.50			80	
SP623000-011	4286	6025	19.68	15.3	85.88			55	
SP623000-013	4166	6375	19.95	16.0	83.27			62	
SP623000-02	4019	5953	18.44	16.1	84.31			53	
SP623356-04	4819	8072	25.01	16.1	80.95			63	
SP623356-05	5029	7181	24.06	15.0	85.22			49	
SP623357-013	2975	4571	15.15	15.1	83.20			32	
SP623359-010	5443	7411	21.64	17.14	86.89	6		60	
SP623359-012	4839	8239	25.67	16.1	80.51			82	
SP623359-02	4542	7025	21.76	16.1	83.08			61	
SP623360-010	4155	5935	17.97	16.51	85.34			50	
SL122 X SP5460-0	5551	7569	22.81	16.61	86.80	8		86	
SP5822-0	4874	7591	22.91	16.61	82.75			87	
SP5481-0	5069	7311	22.97	15.9	85.06			70	
62B26-0	4249	5852	18.92	15.5	86.45	10		90	
62B25-0	5708	7486	22.20	16.99	88.08	2		89	
SL126 X SP5460-0	5104	7328	21.70	16.97	85.11			78	
General Mean	5004	7190	21.95	16.4	85.09			77	
S.E. var. mean		326	.80	.39	1.92			3.8	
above as % Gen. Mean		4.53	3.65	2.38	2.26			4.9	
Diff. for Sig. (odds 19:1)	634 (b)	911	2.95	1.1	NS			11	

Random Block Analysis

Variance Table

Source of variation	D.F.	Mean Squares						Beets per 100'
		Gross	Roots	Sucrose	Purity	Leaf		
		sugar				Spot	Row	
Between replications	5	217122	5.8329	.5797	83.1455			500
Between varieties	35	3351483	24.4973	2.5486	21.8550			1489
Remainder - Error	175	639740	3.8614	.9064	22.1010			88
Total	215							

Calculated F. value 35/175 5.24** 6.34** 2.81** NS 16.92**

Standard footnotes (a),(b),(c, and (d, page 122.

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Clyde McKanna farm, Ft. Jennings, Ohio

Cooperation: F & M Beet Sugar Association, Buckeye Sugars, Inc.

Date of Planting: April 15, 1963

Date of Harvest: October 22, 1963

Experimental Design: 6 x 6 Triple Lattice

Size of Plots: 6 rows x 20' - 36" between rows

Harvested Area per Plot for Root Yield: 4 rows x 18 feet

Samples for Sucrose Determination: 2 samples of 10 beets each taken
consecutively from the outside
harvested rows

Stand Counts: Harvested beets counted when weighed

Recent Field History:

1962 - Corn	300# 6-24-12	100# N. Sidedressed
1961 - Tomatoes	800# 5-20-20	60# N. Sidedressed
1960 - Beets	300# 6-24-12	80# N. Sidedressed

Fertilization of Beet Crop: 300# 6-24-12 with Manganese and Boron
80# N. Sidedressed

Black Root Exposure: None

Leaf Spot Exposure: Moderate

Other Diseases and Pests: None

Soil and Seasonal Conditions: Moist seedbed - Below normal moisture
throughout season

Reliability of Test: Good

Cooperator: F. & M. Beet Sugar Assn. & Buckeye Sugars, Inc. Year: 1963

Location: Clyde McKanna farm, Ft. Jennings, Ohio Expt.: 12
6 X 6 triple lattice analyzed as a random block

	Acre Yield			Clear		Beets	
	Sugar			Juice			
	Recover- able (a lbs.	Gross Roots tons	Sucrose %	Purity %	App. c) Spot (d	Leaf per 100'	No.
SL133 X SP5460-0	8068	19.78	20.4	90.67	2.50	100	
CT5 X SP5460-0	8926	20.67	21.6	90.82	2.50	104	
SL(((122X127)128)129)msXUI160	7966	18.94	21.0	89.95	3.33	101	
SL128 X SP6045ecl.	7202	17.01	21.2	90.44	3.83	107	
SL128 X SL010	7819	17.97	21.8	91.12	4.17	107	
SL129 X SL010	7923	18.37	21.6	91.40	4.00	99	
SL128 X SL0410	7311	17.34	21.1	90.73	3.83	116	
R5651	7664	18.64	20.6	89.21	3.17	87	
(AI-10XAI-12)msXUS401 4n	7672	19.83	19.4	87.97	3.17	100	
SP557ms X US401 4n	7982	19.85	20.3	89.79	2.83	98	
F60-569HO X US 401 4 n	7531	18.76	20.1	88.50	3.00	89	
F61-562HO X US401 4n	7803	19.92	19.6	88.21	2.50	88	
SL126ms X US401 4n	7566	18.40	20.6	90.37	3.17	100	
SL122ms X US401 4n	7534	17.85	21.1	89.42	3.67	110	
F61-562 X SP5460-0	7983	19.64	20.3	88.97	2.00	91	
(AI-10XAI-12)msXSP5460-0	8158	19.16	21.3	89.32	2.83	100	
SP557ms X SP5460-0	7636	18.12	21.1	89.17	2.83	99	
SP62100-030	7942	18.92	21.0	88.75	1.33	96	
SP62100-014	7780	19.13	20.4	89.52	1.93	93	
SP62100-055	7378	18.44	20.0	89.86	1.33	88	
SP623000-011	7569	18.32	20.7	88.20	1.93	76	
SP623000-013	7094	17.33	20.5	88.34	2.17	72	
SP623000-02	6274	16.00	20.0	87.72	2.00	53	
SP623356-04	9131	22.17	20.7	89.78	1.67	86	
SP623356-05	7761	19.98	19.5	87.65	1.33	62	
SP623357-013	5218	14.55	17.9	87.05	2.00	32	
SP623359-010	8041	19.39	20.8	89.24	2.17	74	
SP623359-012	8110	20.22	20.0	86.66	2.17	87	
SP623359-02	7037	18.30	19.3	87.03	3.33	65	
SP623360-010	6111	14.97	20.4	88.86	1.50	62	
SL122 X SP5460-0	7398	18.10	20.5	89.27	2.83	95	
SP5822-0	7690	18.39	20.9	90.09	1.17	102	
SP5481-0	8058	19.86	20.3	89.23	2.00	94	
62B26-0	6277	15.36	20.4	89.86	1.17	89	
62B25-0	8074	20.03	20.2	89.50	1.33	89	
SL126 X SP5460-0	7684	19.24	20.0	89.03	3.33	88	
General Mean	7594	18.58	20.4	89.20	2.50	89	
S.E. var. mean	343	.85	.33		.21	3.8	
above as % Gen. Mean	4.52	4.57	1.62		8.40	4.3	
Diff. for Sig. (odds 19:1)	959	2.37	0.9	(•	0.59	11	

Random Block Analysis				Variance Table			
				Mean Squares			
Source of Variation	D/F	Gross Sugar	Roots	Sucrose	Purity	Leaf Spot	Beets 100' Row
Between replications	5	1244977	5.5376	3.6109	(•	.28	556
Between varieties	35	3199301	15.1828	3.5484		4.62	1791
Remainder - Error	175	707737	4.3106	.6669		.27	89
Total	215						
Calculated F-value	35/175	4.52**	3.52**	5.32**		17.11**	20.12**

•) Too many missing plots for analysis of variance. Data reported as averages of from 4 to 6 plots.

Standard footnotes (a, (b, (c, and (d, page 122.

Cooperator: F. & M. Beet Sugar Assn.

Year: 1963

Location: Merrill, Michigan and Ft. Jennings, Ohio (Combined)
6 X 6 triple lattice analyzed as a random block

Expt.: 17

	Acre yield			Beets per 100'
	Sugar		Leaf Spot	
	Recover- able (a lbs.	Gross Roots tons		
SL133 X SP5460-0	7979	21.53	18.7	90
CT5 X SP5460-0	8466	22.20	19.2	99
SL(((122X127)128)129)msXUI160	8065	21.34	19.1	98
SL128 X SP6045sel.	7311	19.68	18.9	100
SL128 X SLO10	7854	19.96	19.9	99
SL129 X SLO10	7772	20.42	19.3	95
SL128 X SLO410	7343	19.21	19.3	106
R5651	7558	20.26	18.8	81
(AI-10XAI-12)msXUS401 4n	7389	20.88	17.8	94
SP557ms X US401 4n	7561	20.62	18.5	91
F60-569HO X US401 4n	7512	20.84	18.2	82
F61-562HO X US401 4n	7626	21.79	17.7	83
SL126ms X US401 4n	7499	20.69	18.4	91
SL122ms X US401 4n	7274	19.59	18.8	98
F61-562 X SP5460-0	7555	21.02	18.1	89
(AI-10XAI-12)msXSP5460-0	7827	20.84	19.0	94
SP557ms X SP5460-0	7301	19.85	18.6	93
SP62100-030	7560	20.31	18.7	94
SP62100-014	7591	21.31	18.1	86
SP62100-055	7329	20.76	17.9	84
SP623000-011	6797	19.00	18.0	65
SP623000-013	6734	18.64	18.2	67
SP623000-02	6113	17.22	17.9	53
SP623356-04	8602	23.59	18.4	74
SP623356-05	7471	22.02	17.2	56
SP623357-013	4894	14.85	16.5	32
SP623359-010	7726	20.52	18.9	67
SP623359-012	8174	22.95	18.0	84
SP623359-02	7031	20.03	17.7	63
SP623360-010	6023	16.47	18.4	56
SL122 X SP5460-0	7483	20.45	18.5	90
SP5822-0	7641	20.65	18.7	95
SP5481-0	7685	21.42	18.1	82
62B26-0	6065	17.14	18.0	89
62B25-0	7780	21.12	18.5	89
SL126 X SP5460-0	7506	20.47	18.4	83
General Mean	7392	20.27	18.4	83
S.E. var. mean	116	.32	.18	2.0
above as % Gen. Mean	1.57	1.58	0.98	2.41
Diff. for Sig. (odds 19:1)	322 (b	.88	.5	5

Random Block Analysis		Variance Table				
Source of Variation	D/F	Mean Squares				
		Gross	Roots	Sucrose	Purity	Beets
		Sugar			Leaf	100'
Between Locations	1:	2936609	204.6804	299.1218		
Between varieties	35:	1011713	6.0100	.8177		2325
L X V - Error	35:	80085	.6035	.1984		524
Total	71:					23
Calculated F. value	35/35:	12.63**	9.96**	4.12**		22.78**

Standard footnotes (a, (b, (c, and (d, page 122.

Section 3. Combining Ability Tests

Field tests were conducted in 1963 to determine the combining ability of several lines of sugarbeets. The determinations involved four multigerm varieties (SP 5460-0, SP 61151-0, SP 6256-0, and 02 clone) as pollinators and 13 male-sterile monogerm sorts as female parents. The hybridizations were produced by G. J. Hogaboam in a plastic house provided by the Farmers & Manufacturers Beet Sugar Association. The field evaluations of the experimental hybrids were conducted by the Association under the supervision of M. R. Berrett.

Female parental lines in each of the four pollinator compartments of the plastic house were rogued, if necessary, to remove pollen-producing plants before anthesis. The quantity and quality of seed obtained from some of the intended hybridizations were not sufficient for a field test, but so far as practicable all possible hybrid combinations were evaluated in the tests at Ottawa, Ohio, and Bay City, Michigan. The commercial monogerm hybrid SL 126ms X SP 5460-0 was included for comparisons in each field test.

Results: The general combining ability of pollinators or of female lines is judged from significant F values for the various categories of evaluation. Significant differences among the entries permit comparisons between specific F₁'s and the commercial hybrid.

Differences in combining ability for root yield were demonstrated among pollinators in the Ottawa test, with SP 5460-0 having the highest mean value. Significant differences were not shown among the female parents in this test, and this was true also in the Bay City test for both the female parents and pollinators.

Significant differences in mean sucrose percentage among pollinators or female parents were not shown in the Ottawa test. In the Bay City test, significant differences were shown for sucrose percentage among F₁ entries as well as between both pollinators and female parents. Several of the F₁ entries had significantly higher sucrose percentage than the commercial hybrid SL 126ms X SP 5460-0.

Significant differences among the pollinators for coefficient of clear juice purity were shown only in the Bay City test. It is worthy of note that the highest mean value is shown for SP 61151-0 which, along with its progenitor SP 5822-0, has shown excellent quality in several tests.

Significant differences were not shown for gross sugar, recoverable sugar, or for stand among pollinators or female parents in either field test.

Both tests showed significant differences among pollinators in leaf spot tolerance. At Bay City the mean readings indicated higher resistance for the hybrids from 02 clone than for those from SP 61151-0, but at Beltsville, Maryland, and Ottawa, Ohio, the reverse was demonstrated. This interaction of location with varieties is discussed by D. L. Mumford on page 178.

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Walter Helmreich farm, Bay City, Michigan

Cooperation: F & M Beet Sugar Association, Monitor Sugar Divn.

Date of Planting: May 17, 1963

Date of Harvest: October 14, 1963

Experimental Design: 6 x 7 Rectangular Lattice

Size of Plots: 4 rows x 20' - 28" between rows

Harvested Area per Plot for Root Yield: 4 rows x 18 feet

Samples for Sucrose Determination: 2 samples of 10 beets each taken
consecutively from the outside
harvested rows

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1962 - Beans - 300# 5-20-20
1961 - Hay - 450# 0-20-0
1960 - Hay - 450# 0-20-0

Fertilization of Beet Crop: 450# 12-12-12 broadcast in the fall
450# 5-20-20 with Boron & Manganese at

Black Root Exposure: Heavy (Seedling Phase) (planting time)

Leaf Spot Exposure: light

Other Diseases and Pests: None

Soil and Seasonal Conditions: Moist seedbed. Generally good growing
conditions most of the year. Below
normal moisture latter part of season

Reliability of Test: Good

AGRONOMIC EVALUATION TEST

Conducted by: M. R. Berrett

Location: Alphonse Schroeder farm - Ottawa, Ohio

Cooperation: F & M Beet Sugar Association, Buckeye Sugars, Inc.

Date of Planting: May 15, 1963

Date of Harvest: October 25, 1963

Experimental Design: 6 x 6 Triple Lattice

Size of Plots: 4 rows x 20' - 32" between rows

Harvested Area per Plot for Root Yield: 4 rows x 18 feet

Samples for Sucrose Determination: 2 samples of 10 beets each taken
consecutively from the outside
harvested rows

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1962 - Clover and timothy hay
1961 - Wheat 400# 5-20-20
1960 - Beans 200# 0-20-20

Fertilization of Beet Crop: 500# 5-20-20 64# N sidedressed

Black Root Exposure: None

Leaf Spot Exposure: Light

Other Diseases and Pests: None

Soil and Seasonal Conditions: Dry seed bed. Below normal moisture
throughout season

Reliability of Test: Fair

Cooperator: Farmers and Manufacturers Beet Sugar Association

Year: 1963

Yield of Roots in Tons per Acre (6 plot averages)

Expt.: 13&14

Lattice design analyzed as a random block

Expt. 13. Alphonse Schroeder Farm

Expt. 14. Walter Helmreich Farm

Ottawa, Ohio

Bay City, Michigan

Male Parent						Male Parent					
Female: 02Clone: 61151-0: 5460-0: 6256-0						Female: 02Clone: 61151-0: 5460-0: 6256-0					
Code	(63B1)	(63B2)	(63B3)	(63B4)	Ave.	Code	(63B1)	(63B2)	(63B3)	(63B4)	Ave.
X02	--	15.81	15.71	14.92	15.46	X02	--	20.38	18.24	19.04	19.22
X03	--	15.62	15.77	14.92	15.42	X03	19.13	19.09	20.91	20.88	20.00
X04	14.43	--	16.56	15.33	15.42	X04	19.43	19.37	19.87	20.27	19.74
X05	--	--	17.68	16.68	17.18	X05	--	19.99	19.95	21.66	20.53
X06	16.64	--	16.77	17.43	16.93	X06	19.86	20.49	20.67	21.12	20.54
X07	14.99	--	17.83	16.90	16.56	X07	21.18	20.23	19.88	21.18	20.60
X08	14.52	15.82	17.15	17.17	16.17	X08	19.37	19.43	20.66	19.49	19.74
X09	17.41	--	16.90	15.65	16.64	X09	20.53	20.40	20.01	17.94	19.72
X010	15.26	--	17.26	16.32	16.26	X010	21.34	21.92	21.01	20.99	21.32
X011	15.20	16.37	16.53	15.98	16.02	X011	20.10	20.79	20.21	21.34	20.61
X012	17.03	--	--	--	17.03	X012	21.40	--	--	--	21.40
X013	--	--	--	--	--	X013	18.29	--	--	--	18.29
X014	15.45	--	--	--	15.45	X014	19.88	--	--	--	19.88
Male Averages (SL126X5460-0 15.26)						(SL126X5460-0 20.42)					
All F.	15.66	15.91	16.82	16.13	16.11		20.05	20.21	20.14	20.39	20.20
Common F.	15.49	--	17.00	16.40	16.30		20.11	20.22	20.40	20.40	20.28

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	D.F.	MEAN SQUARE	F.
(entire expt.)						
Replications	5	126.6828		5	21.6107	
Varieties	35	5.3933	NS	41	5.2011	1.71**
R X V	175	3.7627		205	3.0499	
Total	215			251		

LSD 5% point 1.99

(analysis of hybrids with common female and common male parents.)

Expt. 13 7 females by 3 males				Expt. 14 8 females by 4 males			
Females	6	.7577	NS	7	1.3320	NS	
Males	2	4.0281	6.07**	3	.1675	NS	
F X M	12	.6637		21	.5886		
Hybrids	20			31			

Female :		Female :	
Code	Description of Female	Code	Description of Female
X02	SL126 X SL128	X08	SP6225-03 (23 X 25)
X03	SL129 X SL133	X09	SP6223-01 (23)
X04	SL (128 X 129) X 133	X010	62B10X08 (EL35C1 X EL32)
X05	SP6224-02 (21 X 24)	X011	SP6225-04 (24 X 25)
X06	SP6224-03 (23 X 24)	X012	SP6224-04 (25 X 24)
X07	SP6225-01 (25)	X013	SL 127 X 128
		X014	SP6223-02 (24 X 23)

Cooperator: Farmers and Manufacturers Beet Sugar Association Year: 1963

Yield of Roots in Tons/Acre Combined (6repl/Loc. X 2 Loc.) Expt.:13&14

Lattice design analyzed as a random block

Expts. 13 & 14 Combined

Michigan and Ohio

Male Parent						Male Parent					
Female:02Clone:61151-0:5460-0:6256-0:Female						Female:02Clone:61151-0:5460-0:6256-0:Female					
Code	::(63B1):	(63B2):	(63B3):	(63B4):	Ave.	:	:	:	:	Ave.	:
X02	:	--	18.10	16.98	16.98	17.34	:				:
X03	:	--	17.35	18.34	17.90	17.85	:				:
X04	:	16.93	--	18.21	17.80	17.63	:				:
X05	:	--	--	18.81	19.17	18.99	:				:
X06	:	18.25	--	18.72	19.27	18.73	:				:
X07	:	18.09	--	18.86	19.04	18.64	:				:
X08	:	16.94	17.63	18.91	18.33	17.95	:				:
X09	:	18.97	--	18.46	16.80	18.05	:				:
X010	:	18.30	--	19.14	18.65	18.68	:				:
X011	:	17.65	18.58	18.37	18.66	18.32	:				:
X012	:	19.22	--	--	--	19.22	:				:
X013	:	--	--	--	--	--	:				:
X014	:	17.67	--	--	--	17.67	:				:
Male Averages						Expt.					
All F.	18.00	17.92	18.48	18.26	18.21						
Common F.	17.88	--	18.67	18.36	18.30						

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	MEAN SQUARE	F.
(entire expt.)					
Locations	1	272.5501			
Varieties	32	1.1158	1.81*		
L X V	32	.6156			
Total	65				

(analysis of hybrids with 7 common female and 3 common male parents)

Females	6	.5143	NS
Males	2	1.1163	NS
F X M	12	.4312	
Hybrids	20		

Female:		Female:	
Code	:Description of Female	Code	:Description of Female
X02	SL126 X SL128	X08	SP6225-03 (23 X 25)
X03	SL129 X SL133	X09	SP6223-01 (23)
X04	SL(128 X 129) X 133	X010	62B10X08 (EL35C1 X EL32)
X05	SP6224-02 (21 X 24)	X011	SP6225-04 (24 X 25)
X06	SP6224-03 (23 X 24)	X012	SP6224-04 (25 X 24)
X07	SP6225-01 (25)	X013	SL 127 X 128
		X014	SP6223-02 (24 X 23)

Cooperator: Farmers and Manufacturers Beet Sugar Association Year: 1963

Percent Sucrose (6 plot averages)

Expt.: 13&14

Lattice design analyzed as a random block

Expt. 13. Alphonse Schroeder Farm Expt. 14. Walter Helmreich Farm
Ottawa, Ohio : Bay City, Michigan

: Male Parent : Male Parent :

Female: 02Clone: 61151-0: 5460-0: 6256-0: Female: 02Clone: 61151-0: 5460-0: 6256-0: Female

Code : (63B1): (63B2): (63B3): (63B4): Ave. : (63B1): (63B2): (63B3): (63B4): Ave.

X02	:	--	21.20	21.38	20.70	21.07:	--	18.20	18.50	17.75	18.13
X03	:	--	21.02	21.40	21.00	21.12:	18.55	18.23	18.22	18.42	18.36
X04	:	21.13	--	21.27	21.02	21.12:	18.67	18.58	18.50	18.38	18.53
X05	:	--	--	19.88	19.85	19.87:	--	17.70	17.17	17.32	17.38
X06	:	20.63	--	19.83	20.38	20.26:	18.35	18.05	17.35	17.70	17.86
X07	:	20.67	--	20.58	19.63	20.27:	17.62	17.40	17.67	17.10	17.45
X08	:	20.77	20.07	19.43	20.13	20.10:	18.38	17.92	17.40	17.38	17.77
X09	:	20.82	--	20.30	21.02	20.69:	18.10	17.75	17.60	17.83	17.82
X010	:	20.48	--	20.20	20.17	20.26:	18.22	18.55	17.82	17.80	18.10
X011	:	20.67	20.43	20.60	20.58	20.57:	18.22	17.50	18.03	17.40	17.79
X012	:	20.42	--	--	--	20.42:	18.03	--	--	--	18.04
X013	:	--	--	--	--	--:	18.93	--	--	--	18.93
X014	:	21.35	--	--	--	21.35:	18.30	--	--	--	18.30
Male Averages (SL126X5460-0 21.08)						Expt.:	(SL126X5460-0 17.57)				
All F.	:	20.77	20.68	20.49	20.45	20.59:	18.31	17.99	17.83	17.71	17.96
Common F.	:	20.74	--	20.32	20.42	20.49:	18.26	18.00	17.82	17.75	17.96

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	D.F.	MEAN SQUARE	F.
(entire expt.)						
Replications	5	10.7325		5	3.4106	
Varieties	35	1.6259	NS	41	1.2752	2.65**
R X V	175	1.2227		205	.4810	
Total	215			251		

LSD 5% Point 0.79

(analysis of hybrids with common female and common male parents)

Expt. 13 7 females by 3 males

Expt. 14. 8 females by 4 males

Females	6	.3792	NS	7	.4916	7.83**
Males	2	.3405	NS	3	.4155	6.62**
F X M	12	.1323		21	.0628	
Hybrids	20			31		

Female :		:Female :	
Code	: Description of Female	: Code	: Description of Female
X02	SL126 X SL128	X08	SP6225-03 (23 X 25)
X03	SL129 X SL133	X09	SP6223-01 (23)
X04	SL(128 X 129) X 133	X010	62B10X08 (EL35C1 X EL32)
X05	SP6224-02 (21 X 24)	X011	SP6225-04 (24 X 25)
X06	SP6224-03 (23 X 24)	X012	SP6224-04 (25 X 24)
X07	SP6225-01 (25)	X013	SL 127 X 128
		X014	SP6223-02 (24 X 23)

Cooperator: Farmers and Manufacturers Beet Sugar Association

Year: 1963

Percent Sucrose Combined (6 repl./Loc X 2 Loc.)

Expt.: 13&14

Lattice design analyzed as a random block

Expts. 13&14 Combined

Michigan and Ohio

Male Parent						Male Parent					
Female: 02Clone: 61151-0: 5460-0: 6256-0: Female						02Clone: 61151-0: 5460-0: 6256-0: Female					
Code	(63B1)	(63B2)	(63B3)	(63B4)	Ave.						Ave.
X02	--	19.70	19.94	19.23	19.60						
X03	--	19.63	19.81	19.71	19.70						
X04	19.90	--	19.88	19.70	19.81						
X05	--	--	18.53	18.58	18.56						
X06	19.49	--	18.59	19.04	19.02						
X07	19.14	--	19.13	18.37	18.86						
X08	19.57	18.99	18.42	18.76	18.94						
X09	19.46	--	18.95	19.43	19.26						
X010	19.35	--	19.01	18.98	19.09						
X011	19.44	18.97	19.32	18.99	19.18						
X012	19.23	--	--	--	19.23						
X013	--	--	--	--	--						
X014	19.83	--	--	--	19.83						
Male Averages						Expt.					
All F.	19.49	19.32	19.16	19.08	19.24						
Common F.	19.48	--	19.04	19.03	19.19						

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	MEAN SQUARE	F.
(entire expt.)					
Locations	1	116.5557			
Varieties	32	.4109	7.21**		
L X V	32	.0570			
Total	65				

(analysis of hybrids with 7 common female and 3 common male parents)

Females	6	.3081	3.76*
Males	2	.4474	5.48*
F X M	12	.0816	
Hybrids	20		

Female:		Female:	
Code	Description of Female	Code	Description of Female
X02	SL126 X SL128	X08	SP6225-03 (23 X 25)
X03	SL129 X SL133	X09	SP6223-01 (23)
X04	SL(128 X 129) X 133	X010	62B10X08 (EL35C1 X EL32)
X05	SP6224-02 (21 X 24)	X011	SP6225-04 (24 X 25)
X06	SP6224-03 (23 X 24)	X012	SP6224-04 (25 X 24)
X07	SP6225-01 (25)	X013	SL 127 X 128
		X014	SP6223-02 (24 X 23)

Cooperator: Farmers and Manufacturers Beet Sugar Association

Year: 1963

Gross Sugar in Pounds/Acre (6 plot averages)

Expt: 13&14

Lattice design analyzed as a random block

Expt. 13. Alphonse Schroeder Farm
Ottawa, Ohio

Expt. 14. Walter Helmreich Farm
Bay City, Michigan

Male Parent

Male Parent

Female: 02Clone: 61151-0: 5460-0: 6256-0: Female: 02Clone: 61151-0: 5460-0: 6256-0: Female																					
Code	:	(63B1)	:	(63B2)	:	(63B3)	:	(63B4)	:	Ave.	:	(63B1)	:	(63B2)	:	(63B3)	:	(63B4)	:	Ave.	
X02	:	--	:	6,689	:	6,717	:	6,164	:	6,523	:	--	:	7,405	:	6,738	:	6,760	:	6,908	
X03	:	--	:	6,502	:	6,727	:	6,239	:	6,489	:	7,098	:	6,947	:	7,588	:	7,689	:	7,331	
X04	:	6,033	:	--	:	7,017	:	6,403	:	6,484	:	7,266	:	7,188	:	7,355	:	7,451	:	7,315	
X05	:	--	:	--	:	6,972	:	6,603	:	6,788	:	--	:	7,072	:	6,851	:	7,488	:	7,137	
X06	:	6,830	:	--	:	6,600	:	7,084	:	6,838	:	7,285	:	7,372	:	7,149	:	7,474	:	7,320	
X07	:	6,163	:	--	:	7,321	:	6,519	:	6,668	:	7,466	:	7,046	:	7,014	:	7,245	:	7,193	
X08	:	6,024	:	6,307	:	6,637	:	6,892	:	6,465	:	7,124	:	6,952	:	7,198	:	6,765	:	7,010	
X09	:	7,265	:	--	:	6,843	:	6,565	:	6,891	:	7,428	:	7,238	:	7,054	:	6,389	:	7,027	
X010	:	6,183	:	--	:	6,959	:	6,560	:	6,567	:	7,764	:	8,125	:	7,484	:	7,473	:	7,712	
X011	:	6,213	:	6,643	:	6,790	:	6,530	:	6,544	:	7,321	:	7,285	:	7,280	:	7,402	:	7,322	
X012	:	6,946	:	--	:	--	:	--	:	6,946	:	7,721	:	--	:	--	:	--	:	7,721	
X013	:	--	:	--	:	--	:	--	:	--	:	6,933	:	--	:	--	:	--	:	6,933	
X014	:	6,563	:	--	:	--	:	--	:	6,563	:	7,267	:	--	:	--	:	--	:	7,267	
Male Averages (SL126X5460-0 6,437)													Expt.		(SL126X5460-0 7,173)					Expt.	
All F.	:	6,469	:	6,535	:	6,858	:	6,556	:	6,596	:	7,334	:	7,263	:	7,171	:	7,214	:	7,246	
Common F.2)	:	6,119	:	6,475	:	6,714	:	6,711	:	6,505	:	7,344	:	7,269	:	7,265	:	7,236	:	7,279	

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	D.F.	MEAN SQUARE	F.
(entire expt.)						
Replications	5	14,433,362		5	2,186,269	
Varieties	35	681,499	NS	41	602,573	1.46*
R X V	175	497,163		205	413,012	
Total	215			251		

LSD 5% point 732

(analysis of hybrids with common female and common male parents)

2 female by 4 male Expt. 13.

8 female by 4 male Expt. 14.

Females	1	12,482	NS	7	193,055	2.55**
Males	3	157,460	NS	3	16,960	NS
F X M	3	46,351		21	75,629	
Hybrids	7			31		

Female:

:Female:

Code	Description of Female	Code	Description of Female
X02	SL126 X SL128	X08	SP6225-03 (23 X 25)
X03	SL129 X SL133	X09	SP6223-01 (23)
X04	SL(128 X 129) X 133	X010	62B10X08 (EL35C1 X EL32)
X05	SP6224-02 (21 X 24)	X011	SP6225-04 (24 X 25)
X06	SP6224-03 (23 X 24)	X012	SP6224-04 (25 X 24)
X07	SP6225-01 (25)	X013	SL 127 X 128
		X014	SP6223-02 (24 X 23)

Cooperator: Farmers and Manufacturers Beet Sugar Association

Year: 1963

Gross Sugar in Pounds/Acre Combined (6 repl/loc by 2 loc.) Expt.: 13 & 14
Lattice design analyzed as a random block

Expts. 13 & 14 combined

Michigan and Ohio

Male Parent					Male Parent				
Female:	02Clone:	61151-0:	5460-0:	6256-0:	Female:	02Clone:	61151-0:	5460-0:	6256-0:
Code	:	(63B1):	(63B2):	(63B3):	(63B4):	Ave.	:	:	:
X02	:	--	7,047	6,727	6,462	6,745	:	:	:
X03	:	--	6,725	7,157	6,964	6,949	:	:	:
X04	:	6,650	--	7,186	6,927	6,921	:	:	:
X05	:	--	--	6,912	7,045	6,979	:	:	:
X06	:	7,058	--	6,875	7,279	7,071	:	:	:
X07	:	6,814	--	7,168	6,882	6,955	:	:	:
X08	:	6,574	6,630	6,917	6,828	6,737	:	:	:
X09	:	7,347	--	6,949	6,477	6,924	:	:	:
X010	:	6,974	--	7,222	7,017	7,071	:	:	:
X011	:	6,767	6,964	7,035	6,966	6,933	:	:	:
X012	:	7,333	--	--	--	7,333	:	:	:
X013	:	--	--	--	--	--	:	:	:
X014	:	6,915	--	--	--	6,915	:	:	:
Male Averages					Expt.				
All F.	6,937	6,842	7,015	6,885	6,933				
Common F.	7,6883	--	7,050	6,911	6,948				

Expt.

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	MEAN SQUARE	F.
(entire expt.)					
Locations	1	6,413,710			
Varieties	32	102,731	NS		
L X V	32	109,288			
Total	65				

(analysis of hybrids with 7 common female and 3 common male parents.)

Females	6	31,388	NS
Males	2	56,040	NS
F X M	12	58,386	
Hybrids	20		

Female:		Female:	
Code	Description of Female	Code	Description of Female
X02	SL126 X SL128	X08	SP6225-03 (23 X 25)
X03	SL129 X SL133	X09	SP6223-01 (23)
X04	SL(128 X 129) X 133	X010	62B10X08 (EL35C1 X EL32)
X05	SP6224-02 (21 X 24)	X011	SP6225-04 (24 X 25)
X06	SP6224-03 (23 X 24)	X012	SP6224-04 (25 X 24)
X07	SP6225-01 (25)	X013	SL 127 X 128
		X014	SP6223-02 (24 X 23)

Cooperator: Farmers and Manufacturers Beet Sugar Association Year: 1963

Clear Juice App. Purity (6 plot averages)

Expt.: 13&14

Lattice design analyzed as a random block

Expt. 13. Alphonse Schroeder Farm

Expt. 14. Walter Helmreich Farm

Ottawa, Ohio

Bay City, Michigan

Male Parent

Male Parent

Female: 02Clone: 61151-0: 5460-0: 6256-0: Female: 02Clone: 61151-0: 5460-0: 6256-0: Female

Code : (63B1): (63B2): (63B3): (63B4): Ave. : (63B1): (63B2): (63B3): (63B4): Ave.

X02 : -- 91.83 92.01 90.70 91.51 : -- 90.42 90.07 90.34 90.28

X03 : -- 91.34 91.32 90.41 90.99 : 90.56 89.90 89.17 90.16 89.95

X04 : 91.39 -- 91.41 92.23 91.68 : 89.81 91.00 89.52 90.65 90.25

X05 : -- -- 89.47 89.89 89.68 : -- 89.17 88.86 87.44 88.49

X06 : 91.07 -- 90.07 90.33 90.49 : 89.69 89.72 89.57 87.75 89.18

X07 : 90.35 -- 90.03 89.38 89.92 : 88.63 88.78 88.75 88.27 88.61

X08 : 91.24 90.61 89.87 90.49 90.55 : 89.75 91.47 88.99 90.42 90.16

X09 : 91.45 -- 90.65 91.39 91.16 : 91.72 91.07 89.16 90.74 90.67

X010 : 90.43 -- 90.49 89.96 90.29 : 89.57 90.37 88.44 88.65 89.26

X011 : 90.30 90.34 90.29 90.12 90.26 : 90.52 89.55 89.60 89.01 89.67

X012 : 90.28 -- -- -- 90.28 : 90.21 -- -- -- 90.21

X013 : -- -- -- -- -- : 90.71 -- -- -- 90.71

X014 : 90.92 -- -- -- 90.92 : 89.83 -- -- -- 89.83

Male Averages (SL126X5460-0 91.84) Expt. Expt.

All F. 90.83 91.03 90.55 90.49 90.71 90.09 90.15 89.21 89.34 89.71

Common F. 90.89 -- 90.40 90.56 90.62 90.03 90.23 89.15 89.46 89.72

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	D.F.	MEAN SQUARE	F.
(entire expt.)						
Replications	5	6.9333		5	46.9776	
Varieties	35	3.0353	2.29**	41	5.3736	NS
R X V	175	1.3244		205	4.2503	
Total	215			251		

(analysis of hybrids with common female and common male parents)

Expt. 13 7 females by 3 males

Expt. 14. 8 females by 4 males

Females	6	1.0899	6.11**	7	1.8108	3.89**
Males	2	.4361	NS	3	2.0106	4.32*
F X M	12	.1785		21	.4655	
Hybrids	20			31		

Female:		Female :	
Code : Description of Female		: Code : Description of Female	
X02 SL126 X SL128		X08 SP6225-03 (23 X 25)	
X03 SL129 X SL133		X09 SP6223-01 (23)	
X04 SL(128 X 129) X 133		X010 62B10X08 (EL35C1 X EL32)	
X05 SP6224-02 (21 X 24)		X011 SP6225-04 (24 X 25)	
X06 SP6224-03 (23 X 24)		X012 SP6224-04 (25 X 24)	
X07 SP6225-01 (25)		X013 SL 127 X 128	
		X014 SP6223-02 (24 X 23)	

Standard footnotes (a,(b,(c, and (d, page 122.

Cooperator: Farmers and Manufacturers Beet Sugar Association

Year: 1963

Clear Juice App. Purity (Combined) (6 repl/Loc. X 2 Loc.) Expt.: 13&14

Lattice design analyzed as a random block

Expts. 13 & 14 Combined

Michigan and Ohio

Male Parent					Male Parent				
Female: 02Clone: 61151-0: 5460-0: 6256-0: Female					02Clone: 61151-0: 5460-0: 6256-0: Female				
Code : (63B1): (63B2): (63B3): (63B4): Ave.					: : : : :				
X02	: --	91.12	91.04	90.52	90.89	:			
X03	: --	90.62	90.25	90.28	90.38	:			
X04	: 90.60	--	90.47	91.44	90.83	:			
X05	: --	--	89.16	88.67	88.92	:			
X06	: 90.38	--	89.82	89.04	89.75	:			
X07	: 89.49	--	89.39	88.82	89.23	:			
X08	: 90.49	91.04	89.43	90.45	90.35	:			
X09	: 91.58	--	89.90	91.06	90.85	:			
X010	: 90.00	--	89.46	89.30	89.59	:			
X011	: 90.41	89.95	89.94	89.57	89.97	:			
X012	: 90.24	--	--	--	90.24	:			
X013	: --	--	--	--	--	:			
X014	: 90.37	--	--	--	90.37	:			
Male Averages					Expt.				Expt.
All F.	90.40	90.68	89.89	89.92	90.13				
Common F.	90.42	--	89.77	89.95	90.05				

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	MEAN SQUARE	F.
(entire expt.)					
Locations	1	22.0432	126.54**		
Varieties	32	1.2410	7.12**		
L X V	32	.1742			
Total	65				

(analysis of hybrids with 7 common female and 3 common male parents.)

Females	6	1.1192	4.49*
Males	2	.7838	NS
F X M	12	.2490	
Hybrids	20		

Female :		Female :	
Code	Description of Female	Code	Description of Female
X02	SL126 X SL128	X08	SP6225-03 (23 X 25)
X03	SL129 X SL133	X09	SP6223-01 (23)
X04	SL(128 X 129) X 133	X010	62B10X08 (EL35C1 X EL32)
X05	SP6224-02 (21 X 24)	X011	SP6225-04 (24 X 25)
X06	SP6224-03 (23 X 24)	X012	SP6224-04 (25 X 24)
X07	SP6225-01 (25)	X013	SL 127 X 128
		X014	SP6223-02 (24 X 23)

Standard footnotes (a, (b, (c, and (d, page 122.

Cooperator: Farmers and Manufacturers Beet Sugar Association Year: 1963

Recoverable Sugar in Pounds/Acre (a) Expt.: 13&14

Calculated from Average: Tons/Acre, % Sucrose, & % Purity

Expt. 13. Alphonse Schroeder Farm Expt. 14. Walter Helmreich Farm

Ottawa, Ohio : Bay City, Michigan

: Male Parent : Male Parent :

Female:02Clone:61151-0:5460-0:6256-0:Female:02Clone:61151-0:5460-0:6256-0:Female

Code : (63B1): (63B2): (63B3): (63B4): Ave. : (63B1): (63B2): (63B3): (63B4): Ave.

X02 : -- 5629 5665 5047 5447 : -- 6008 5420 5461 5630

X03 : -- 5450 5589 5085 5375 : 5770 5564 5977 6190 5875

X04 : 5068 -- 5858 5461 5462 : 5789 5915 5822 6070 5874

X05 : -- -- 5566 5300 5433 : -- 5549 5325 5608 5494

X06 : 5660 -- 5347 5751 5586 : 5796 5885 5681 5639 5750

X07 : 5020 -- 5897 5240 5386 : 5752 5462 5448 5540 5551

X08 : 4993 5175 5329 5617 5279 : 5671 5783 5609 5482 5636

X09 : 6032 -- 5598 5467 5699 : 6209 5956 5521 5220 5727

X010 : 5072 -- 5666 5279 5339 : 6164 6580 5758 5779 6070

X011 : 5084 5747 5509 5297 5409 : 5946 5761 5780 5796 5821

X012 : 5623 -- -- -- 5623 : 6219 -- -- -- 6219

X013 : -- -- -- -- -- : 5652 -- -- -- 5652

X014 : 5421 -- -- -- 5421 : 5806 -- -- -- 5806

Male Averages

Expt.

Expt.

All F. 5330 5500 5602 5354 5440 5889 5846 5634 5679 5765

Common F. 5276 -- 5600 5445 5440 5887 5863 5700 5714 5791

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	D.F.	MEAN SQUARE	F.
(analysis of hybrids with common female and common male parents.)						
Expt. 13, 7 females by 3 males				Expt. 14, 8 females by 4 males		
Females	6	69,361	NS	7	105,849	NS
Males	2	184,943	NS	3	76,492	NS
F X M	12	90,874		21	58,853	
Hybrids	20			31		

Female:		:Female:	
Code	Description of Female	: Code	Description of Female
X02	SL126 X SL128	X08	SP6225-03 (23 X 25)
X03	SL129 X SL133	X09	SP6223-01 (23)
X04	SL(128 X 129) X 133	X010	62B10X08 (EL35C1 X EL32)
X05	SP6224-02 (21 X 24)	X011	SP6225-04 (24 X 25)
X06	SP6224-03 (23 X 24)	X012	SP6224-04 (25 X 24)
X07	SP6225-01 (25)	X013	SL 127 X 128
		X014	SP6223-02 (24 X 23)

Standard footnotes (a,(b,(c, and (d, page 122.

Cooperator: Farmers and Manufacturers Beet Sugar Association Year: 1963

Recoverable Sugar/Acre Calculated from Combined Averages (a Expt.:13&14

Male Parent						Male Parent					
Female:02Clone:61151-0:5460-0:6256-0:Female						:02Clone:61151-0:5460-0:6256-0:Female					
Code	:	(63B1):	(63B2):	(63B3):	(63B4): Ave.	:	:	:	:	:	Ave.
X02	:	--	5882	5576	5306	:					5588
X03	:	--	5550	5868	5702	:					5707
X04	:	5489	--	5879	5829	:					5732
X05	:	--	--	5469	5516	:					5493
X06	:	5762	--	5554	5740	:					5685
X07	:	5482	--	5698	5437	:					5539
X08	:	5385	5509	5503	5576	:					5493
X09	:	6156	--	5597	5376	:					5710
X010	:	5681	--	5756	5576	:					5671
X011	:	5562	5646	5685	5622	:					5629
X012	:	5965	--	--	--	:					5965
X013	:	--	--	--	--	:					--
X014	:	5676	--	--	--	:					5676
Male Averages						Expt.					
All F.	:	5684	5647	5659	5568	:					5637
Common F.	:	5645	--	5667	5594	:					5635

Expt.

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	MEAN SQUARE	F.
--------	------	-------------	----	-------------	----

(analysis of hybrids with 7 common female and 3 common male parents)

Females	6	24,923	NS
Males	2	10,014	NS
F X M	12	41,735	
Hybrids	20		

Female:			:Female :		
Code	:	Description of Female	:Code	:	Description of Female
X02	:	SL126 X SL128	X08	:	SP6225-03 (23 X 25)
X03	:	SL129 X SL133	X09	:	SP6223-01 (23)
X04	:	SL(128 X 129) X 133	X010	:	62B10X08 (EL35C1 X EL32)
X05	:	SP6224-02 (21 X 24)	X011	:	SP6225-04 (24 X 25)
X06	:	SP6224-03 (23 X 24)	X012	:	SP6224-04 (25 X 24)
X07	:	SP6225-01 (25)	X013	:	SL 127 X 128
	:		X014	:	SP6223-02 (24 X 23)

Standard footnotes (a,(b,(c, and (d, page 122.

Cooperator: Farmers and Manufacturers Beet Sugar Association

Year: 1963

Beets per 100 feet of Row (6 plot averages)

Expt.: 13&14

Lattice design analyzed as a random block

Expt. 13 Alphonse Schroeder Farm

Expt. 14. Walter Helmreich Farm

Ottawa, Ohio

Bay City, Michigan

: Male Parent :

: Male Parent :

Female: 02Clone: 61151-0: 5460-0: 6256-0: Female : 02Clone: 61151-0: 5460-0: 6256-0: Female

Code : (63B1): (63B2): (63B3): (63B4): Ave. : (63B1): (63B2): (63B3): (63B4): Ave.

X02	:	--	84	85	87	85	:	--	87	83	89	86
X03	:	--	88	82	88	86	:	82	88	94	94	90
X04	:	83	--	86	81	83	:	80	79	90	87	84
X05	:	--	--	80	80	80	:	--	76	80	85	80
X06	:	79	--	84	74	79	:	95	82	90	85	88
X07	:	81	--	78	74	78	:	90	80	74	89	83
X08	:	81	88	70	77	79	:	87	85	80	81	83
X09	:	76	--	82	81	80	:	86	84	80	76	82
X010	:	82	--	78	83	81	:	86	83	83	80	83
X011	:	84	82	75	85	82	:	92	88	94	91	91
X012	:	85	--	--	--	85	:	91	--	--	--	91
X013	:	--	--	--	--	--	:	83	--	--	--	83
X014	:	75	--	--	--	75	:	80	--	--	--	80

Male Averages (SL126X5460-0 88) Expt.

(SL126X5460-0 92) Expt.

All F.	81	86	80	81	81	87	83	85	86	85
Common F.	81	--	79	79	80	87	84	86	85	85

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	D.F.	MEAN SQUARE	F.
(entire expt.)						
Replications	5	1161		5	83	
Varieties	35	126	2.10**	41	175	1.99**
R X V	175	60		205	88	
Total	215			251		

LSD 5% Point 9

LSD 5% Point 11

(analysis of hybrids with common female and common male parents)

Expt. 13. 7 females by 3 males				Expt. 14. 8 females by 4 males		
Females	6	18	NS	7	52	NS
Males	2	7	NS	3	17	NS
F X M	12	19		21	26	
Hybrids	20			31		

Female:			Female:		
Code : Description of Female			: Code : Description of Female		
X02	SL126 X SL128		X08	SP6225-03	(23 X 25)
X03	SL129 X SL133		X09	SP6223-01	(23)
X04	SL(128 X 129) X 133		X010	62B10X08	(EL35C1 X EL32)
X05	SP6224-02 (21 X 24)		X011	SP6225-04	(24 X 25)
X06	SP6224-03 (23 X 24)		X012	SP6224-04	(25 X 24)
X07	SP6225-01 (25)		X013	SL 127 X 128	
			X014	SP6223-02	(24 X 23)

Cooperator: Farmers and Manufacturers Beet Sugar Association

Year: 1963

Beets/100' Combined (6 repl./Loc. by 2 Locations)

Expt.: 13&14

Lattice design analyzed as a random block

Expts. 13 & 14 Combined

: Michigan and Ohio :

Female: 02Clone:61151-0:5460-0:6258-0:Female:02Clone:61151-0:5460-0:6256-0:Female

Code : (63B1): (63B2): (63B3): (63B4): Ave. : : : : Ave.

X02	:	--	85	84	88	86	:
X03	:	--	88	88	91	89	:
X04	:	81	--	88	84	84	:
X05	:	--	--	80	82	81	:
X06	:	87	--	87	79	84	:
X07	:	85	--	76	81	81	:
X08	:	84	86	75	79	81	:
X09	:	81	--	81	78	80	:
X010	:	84	--	81	82	82	:
X011	:	88	85	85	88	86	:
X012	:	88	--	--	--	88	:
X013	:	--	--	--	--	--	:
X014	:	78	--	--	--	78	:

Male Averages (SL126X5460-0 90) Expt.

Expt.

All F. 84 86 83 83 84

Common F. 84 -- 82 82 83

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	MEAN SQUARE	F.
(entire expt.)					
Locations	1	404			
Varieties	32	32	NS		
L X V	32	18			
Total	65				

(analysis of hybrids with 7 common female and 3 common male parents)

Females	6	22	NS
Males	2	14	NS
F X M	12	11	
Hybrids	20		

Female:		:Female :	
Code	Description of Female	: Code	Description of Female
X02	SL126 X SL128	X08	SP6225-03 (23 X 25)
X03	SL129 X SL133	X09	SP6223-01 (23)
X04	SL(128 X 129) X 133	X010	62B1OX08 (EL35C1 X EL32)
X05	SP6224-02 (21 X 24)	X011	SP6225-04 (24 X 25)
X06	SP6224-03 (23 X 24)	X012	SP6224-04 (25 X 24)
X07	SP6225-01 (25)	X013	SL 127 X 128
		X014	Sp6223-02 (24 X 23)

Cooperator: Farmers and Manufacturers Beet Sugar Association

Year: 1963

Leaf Spot Ratings (3 plot ave. in Md. 6 plot ave. Mich.) Expt.: _____

Lattice design analyzed as a random block

Plant Industry Station, Beltsville, Md.: Expt. 14. Walter Helmreich Farm

Rated 9/19/63@

: Rated 10/2/63@

Male Parent					Male Parent					
Female:02Clone:61151-0:5460-0:6256-0:Female:	02Clone:61151-0:5460-0:6256-0:Female:	02Clone:61151-0:5460-0:6256-0:Female:	02Clone:61151-0:5460-0:6256-0:Female:	02Clone:61151-0:5460-0:6256-0:Female:	02Clone:61151-0:5460-0:6256-0:Female:	02Clone:61151-0:5460-0:6256-0:Female:	02Clone:61151-0:5460-0:6256-0:Female:	02Clone:61151-0:5460-0:6256-0:Female:	02Clone:61151-0:5460-0:6256-0:Female:	02Clone:61151-0:5460-0:6256-0:Female:
Code	(63B1)	(63B2)	(63B3)	(63B4)	Ave.	(63B1)	(63B2)	(63B3)	(63B4)	Ave.
X02	--	3.33	3.33	2.67	3.11	--	2.00	2.83	2.17	2.33
X03	3.33	3.33	3.67	3.00	3.33	2.00	1.83	2.83	2.17	2.21
X04	4.00	3.33	4.00	3.33	3.67	1.17	1.83	2.83	2.17	2.00
X05	--	3.00	3.00	2.33	2.78	--	1.33	2.33	1.83	1.83
X06	3.00	2.33	3.00	2.67	2.75	1.17	1.67	1.83	2.33	1.75
X07	3.67	2.67	3.67	2.67	3.17	1.50	2.00	2.67	2.00	2.04
X08	3.33	3.33	3.00	2.67	3.08	1.33	1.83	2.50	2.00	1.92
X09	4.00	3.33	3.67	3.00	3.50	1.50	2.00	2.17	2.00	1.92
X010	4.00	3.33	3.67	3.33	3.58	2.00	1.67	2.50	2.00	2.04
X011	3.33	3.00	3.33	3.00	3.17	1.67	2.00	2.83	2.17	2.17
X012	4.00	--	--	--	4.00	2.00	--	--	--	2.00
X013	4.00	--	--	--	4.00	1.83	--	--	--	1.83
X014	4.00	--	--	--	4.00	1.67	--	--	--	1.67
Male Averages (SL 126 X 5460 = 3.67) Expt.					(SL126 X 5460 = 2.83) Exp.					
All F.	3.70	3.10	3.43	2.87	3.28	1.62	1.82	2.53	2.08	2.01
Common F.	3.58	3.08	3.50	2.96	3.28	1.54	1.85	2.52	2.11	2.01

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	D.F.	MEAN SQUARE	F.
(entire expt.)						
Replications	2	.45	1.80	5	.40	NS
Varieties	41	.66	2.54 **	41	1.15	6.70 **
R X V	82	.25		205	.17	
Total	125			251		

(analysis of hybrids with 8 common female and 4 common male parents.)

Females	7	3.27	7.60 **	2.92	1.30
Males	3	6.78	15.77 **	45.70	20.31 **
F X M	21	.43		2.25	
Hybrids	31				

Female:		Female :	
Code	: Description of Female	: Code	: Description of Female
X02	SL126 X SL128	X08	SP6225-03 (23 X 25)
X03	SL129 X SL133	X09	SP6223-01 (23)
X04	SL(128 X 129) X 133	X010	62B10X08 (EL35C1 X EL32)
X05	SP6224-02 (21 X 24)	X011	SP6225-04 (24 X 25)
X06	SP6224-03 (23 X 24)	X012	SP6224-04 (25 X 24)
X07	SP6225-01 (25)	X013	SL 127 X 128
		X014	SP 6223-02 (24 X 23)

@ Rated on a scale of 0 to 10 with 0 being disease free and 10 lethal.

Cooperator: Farmers and Manufacturers Beet Sugar Association

Year: 1963

Leaf Spot Ratings (6 plot Ave.) Ohio & Mich. & Ohio Combined. Expt.: 13&14

Lattice design analyzed as a random block

Expt. 13. Alphonse Schroeder Farm
Ottawa, Ohio, Rated 10/8/63@

Expts. 13&14. Michigan and Ohio Combined
: 33 hybrids common to both tests.

Male Parent					Male Parent				
Female:02Clone:61151-0:5460-0:6256-0:Female:02Clone:61151-0:5460-0:6256-0:Female									
Code	:	(63B1):	(63B2):	(63B3):	(63B4):	Ave.	:	:	Ave.
X02	:	--	1.00	2.00	1.17	1.39	:	--	1.50 2.42 1.67 1.86
X03	:	--	1.17	1.83	1.67	1.56	:	--	1.50 2.33 1.92 1.92
X04	:	1.00	--	2.00	1.83	1.61	:	1.09	-- 2.42 2.00 1.84
X05	:	--	--	1.33	1.00	1.17	:	--	-- 1.83 1.42 1.63
X06	:	1.33	--	1.33	1.00	1.22	:	1.25	-- 1.58 1.67 1.50
X07	:	1.00	--	1.33	1.17	1.17	:	1.25	-- 2.00 1.59 1.61
X08	:	1.61	1.00	1.50	1.17	1.32	:	1.47	1.42 2.00 1.59 1.62
X09	:	1.61	--	1.67	1.17	1.48	:	1.56	-- 1.92 1.59 1.69
X010	:	1.33	--	1.67	1.33	1.44	:	1.67	-- 2.09 1.67 1.81
X011	:	1.00	1.00	1.67	1.17	1.21	:	1.34	1.50 2.25 1.67 1.69
X012	:	1.33	--	--	--	1.33	:	1.67	-- -- -- 1.67
X013	:	--	--	--	--	--	:	--	-- -- -- --
X014	:	1.50	--	--	--	1.50	:	1.59	-- -- -- 1.59
Male Averages (SL 126 X 5460 = 2.17) Expt.					Expt.				
All F.	:	1.30	1.04	1.63	1.27	1.31	:	1.43 1.48	2.08 1.68 1.67
Common F.	:	1.31	1.00	1.59	1.17	1.27	:	1.38 --	2.04 1.68 1.70

ANALYSIS OF VARIANCE

SOURCE	D.F.	MEAN SQUARE	F.	D.F.	MEAN SQUARE	F.
(entire expt.)						
Replications	5	.69		Loc. 1	288.55	103.05 **
Varieties	35	.70	4.67**	Var. 32	8.12	2.90 **
R X V	175	.15		LXV 32	2.80	
Total	215			65		
LSD 5% Point		.44				

(analysis of hybrids with common female and common male parents)

Expt. 13. 2 common Females by 4 Males				Expt. 13&14. 7 Females by 3 Males			
Females	1	2.00	NS	6	.04	NS	
Males	3	4.83	NS	2	.77	15.40	**
F X M	3	3.67		12	.05		
Hybrids	7			20			

Female:		:Female :	
Code	Description of Female	: Code	Description of Female
X02	SL126 X SL128	X08	SP6225-03 (23 X 25)
X03	SL129 X SL133	X09	SP6223-01 (23)
X04	SL(128 X 129) X 133	X010	62B10X08 (EL35C1 X EL32)
X05	SP6224-02 (21 X 24)	X011	SP6225-04 (24 X 25)
X06	SP6224-03 (23 X 24)	X012	SP6224-04 (25 X 24)
X07	SP6225-01 (25)	X013	SL 127 X 128
		X014	SP6223-02 (24 X 23)

@ Rated on a scale of 0 to 10 with 0 being disease free and 10 lethal.

TEST FOR STRAINS OF CERCOSPORA BETICOLA

by David L. Mumford

Field observations in 1962, comparing hybrids from crosses involving male parents 5822-0 and O2-clone, indicated a difference in their reaction to leaf spot at Beltsville, Maryland, and at Bay City, Michigan. Hybrids from crosses involving these two males were planted in 4 locations in 1963 to again observe their reaction to infection by Cercospora beticola. Hybrids grown at Beltsville were artificially inoculated with an application of diseased leaves collected locally and ground into small particles. Leaf spot at the other locations was due to natural infection. Ratings based on a 0 to 10 scale were assigned to each hybrid. Lighter infection at the Michigan and Ohio locations made it necessary to expand the lower part of the scale in assigning ratings. At each location careful observation of diseased leaves indicated that the pathogen involved was C. beticola. The average leaf spot ratings are listed in the table below.

Hybrids from O2-clone received significantly lower leaf spot ratings at 2 locations near Bay City, Michigan. Hybrids from 5822-0 received significantly lower ratings at Beltsville, Maryland. There was no significant difference in the ratings assigned hybrids from these 2 males at the Ohio location. Similar results were obtained when leaf spot ratings were assigned the 1963 greenhouse hybrids involving these same 2 males grown at Beltsville, Michigan and Ohio. Data on this material are presented elsewhere in this report.

This complete reversal of reaction at the 2 most widely separated locations could have one or more explanations, but in any case it points out the value of making selections for disease resistance in the area where the varieties will be grown commercially and with isolates of the pathogen that are present in that area. It is not known whether the difference in reaction reported here is due to strains of the pathogen, effect of environment on host reaction, or intensity of infection. Studies in the greenhouse with different isolates of the pathogen may indicate the relative importance of pathogenic strains in this phenomenon.

Average Leaf Spot Ratings for Hybrids Planted at 4 Locations in 1963

Location	Male parent	Female parent					Mean
		EL34C1	EL32C1	6123-01	EL33C1	A112ms	
Kawkawlin, O2-clone			1.33	1.33	1.40	1.43	1.37 **
Mich. 5822-0			1.33	2.26	1.83	1.67	1.77
(6 reps.) Mean			1.33	1.80	1.62	1.55	
Beltsville O2-clone			3.33	4.00	4.00	4.00	3.83
Md. 5822-0			3.00	2.67	3.33	3.00	3.00 **
(3 reps.) Mean			3.17	3.34	3.67	3.50	
Ottawa, O2-clone		1.43		1.33	1.43	1.43	1.41
Ohio 5822-0		1.33		1.33	1.43	1.27	1.34 ns
(4 reps.) Mean		1.38		1.33	1.43	1.35	
Bay City, O2-clone					1.57	1.67	1.62 *
Mich. 5822-0					2.00	2.43	2.22
(3 reps.) Mean					1.79	2.05	

** - Significantly lower leaf spot rating (p - .01) single location

* - " " " " " (p - .05) " "

ns - No significant difference.

P A R T V

DEVELOPMENT AND EVALUATION
of
SUGARBEET BREEDING MATERIAL AND VARIETIES CARRYING
RESISTANCE TO LEAF SPOT AND CURLY TOP

Foundation Project 25

J. O. Gaskill
G. E. Coe

C. W. Bennett
A. M. Murphy

J. A. Elder

Cooperation:

American Crystal Sugar Company
The Great Western Sugar Company
Holly Sugar Corporation
National Sugar Manufacturing Company
Tribune Branch Station, Kansas
Agricultural Experiment Station
Southeastern Substation, New Mexico
Agricultural Experiment Station
Panhandle Experiment Station, Oklahoma
Agricultural Experiment Station

DEVELOPMENT AND EVALUATION OF SUGARBEET BREEDING
MATERIAL AND VARIETIES CARRYING RESISTANCE TO
LEAF SPOT AND CURLY TOP, 1963 ^{1/}

(A phase of Beet Sugar Development Foundation Project No. 25)

John O. Gaskill

This report pertains largely to the development and evaluation of sugarbeet lines and varieties resistant to both leaf spot and curly top -- so-called "LSR-CTR" material. However, as a part of the program of evaluating leaf spot resistant (LSR) lines for combining ability, top crosses were made in 1962, using several types of pollinators. Some of these pollinators are known to be resistant to both leaf spot and black root (LSR-BRR) and susceptible to curly top. This report includes 1963 field results for such top crosses, and consequently portions of the report will be of special interest to those in need of LSR-BRR material where curly top is not a factor.

In general, work involved in the initial selection and preliminary (disease resistance and sucrose) evaluation of type-0 lines is omitted in this report. An exception is the presentation of a table of results showing progress in the development of LSR-CTR, type-0, monogerm lines in cooperation with Dr. C. W. Bennett, Salinas, California. The major portion of the report deals with the results of cooperative evaluation tests of LSR-CTR varieties. This program involved agronomic and observational tests in 8 states.

Top-cross Tests

Two top-cross tests (Experiments 2A and 3A) were conducted at Ft. Collins in 1963. Descriptions of parental and other material involved in both tests are given in an accompanying table. The summarized results obtained from the 2 tests are presented in separate tables, together with an explanatory page for each test. Also included in the 2 summary tables are the results of CTR evaluation of some of the material performed by A. M. Murphy at Thatcher, Utah.

^{1/} This progress report pertains to breeding and evaluation work conducted at Ft. Collins, Colorado, and to cooperative tests conducted at other locations, by various investigators, with results summarized at the Ft. Collins station. The work at Ft. Collins was performed in cooperation with Colorado Agricultural Experiment Station, Beet Sugar Development Foundation, and Board of County Commissioners of Larimer County, and was supported in part by funds contributed by the National Sugar Manufacturing Co.

The results of Experiment 2A indicate considerable promise for the type-0 lines, SP 581181sl and SP 581222sl, on the basis of general combining ability (e.g. in gross sucrose). SP 581179sl also produced certain excellent hybrids. The most striking thing in the table is the high general combining ability shown for the LSR-BRR pollinator, SP 59B18-0. The 3 top-cross hybrids having that number as the ♂ parent and the CMS phase of the above 3 type-0 lines as the respective ♀ parents averaged 5435 pounds gross sucrose per acre. This average is 39% above the gross sucrose yield shown for SP 5481-0 and 42% above that shown for the best of the 2 monogerm checks, SL 126 MS x SP 5460-0. These differences are highly significant. It also should be noted that the sucrose percentage of each of the same 3 top-cross hybrids was significantly above that of SP 5481-0 and SL 126 MS x SP 5460-0. (Page 184)

Also of special interest in the Experiment-2A table is the superior performance of the LSR-CTR top-cross hybrids, SP 581181sl (CMS) x SP 6051-0 and SP 581222sl (CMS) x SP 6051-0. Each of these hybrids significantly exceeded SL 126 MS x SP 5460-0 in gross sucrose and in sucrose percentage, each was about equal to SL 126 MS x SP 5460-0 in LSR, and each was given a curly top rating of 4, the same as for SP 6051-0.

Among the high lights of results for the diploid LSR-CTR hybrids, as shown in the table for Experiment 3A, is the high general combining ability (in gross sucrose) for 2 type-0 lines (SP 592013sl and FC 502/2) and for 2 pollinators (SL 932 and SP 581813-00). On the basis of results shown for certain combinations involving these lines, the following double cross appears promising: (FC 502/2 CMS♀ x SP 592013sl) CMS♀ x (SL 932 aa ♀ x SP 581813-00). The F₁ hybrids have been made on a greenhouse scale, and the double cross is to be made in 1964. This double cross is expected to have moderate curly top resistance and to be somewhat superior to SL 126 MS x SP 5460-0 in leaf spot resistance. Under conditions such as those existing in the 3A test of 1963, it should be substantially better than SL 126 MS x SP 5460-0 in gross sucrose yield and in sucrose percentage. (Page 186)

The performance of the 2 triploid hybrids in Experiment 3A is of interest and suggests the advisability of further exploration of the use of the Savitsky tetraploid line, S-62-16, as a pollinator of diploid, monogerm, LSR, CMS lines for the production of triploid, LSR-CTR hybrids.

TOP-CROSS TESTS, FT. COLLINS, COLORADO, 1963
Experiments 2A and 3A

Description of Material

Strain designation	Seed type	LSR ^a	CTR ^a	Description
<u>Type-0 lines:</u>				
FC 501	mm	+++	-?	S ₂ inbred, rr, from the cross, US 201 MM x SP 51101- mm.
FC 502/2	mm	+++	-	S ₂ inbred, rr, from the cross, US 201 MM x V. F. Savitsky #715 mm.
FC 503	mm	++	-	SP 571702-0, RR, derived (by selfing) from V.F. Savitsky #716 mm inbred.
SP 561606-0	mm	++	-?	S ₃ inbred, rr, derived from SP 51100-0.
SP 561609-0	mm	±	-?	S ₃ inbred, rr, derived from SP 51101-461.
SP 581179sl	mm	+++	-?	S ₁ inbred, rr, from the cross, US 201 MM x type-0 mm.
SP 581181sl	mm	++	-?	S ₁ inbred, rr, from the cross, US 201 MM x type-0 mm.
SP 581194sl	mm	+++	-	S ₁ inbred, rr, from the cross, US 201 MM x type-0 mm.
SP 581222sl	mm	++	-?	S ₁ inbred, rr, from the cross, US 201 MM x type-0 mm.
SP 592013sl	mm	+++	-	rr, derived (by selfing) from V.F. Savitsky #6-2 inbred.
<u>Pollinators:</u>				
S-62-16	M	+	++	4n; F ₄ ; from the cross, 4n mono. CTR x 4n US 401; received from V.F. Savitsky.
SL 932	MM	-	+++	F ₁ , CT5aa = CT9A; from P.V. Owen.
SP 5481-0	MM	++	-	Open-pol. black root resistant com'l.var.
SP 581813-00	MM	++	+	Open-pol. var. derived by mass sel. from the cross, (SL 202 & US 22/4) x (US 22/3 x US 201)
SP 59B18-0	MM	++	-?	Black root res. hyb. from H.W. Bock-stahler and G.J. Hogaboam.
SP 591101-0	mm	++	-	Black root res. open-pol. var. with equiv. of 1 gen. of sel. for res. to Botrytis (storage rot).
SP 6051-0	MM	+	++	Open-pol. var. developed by U.S.D.A. and N.M. Agr. Exp. Sta.; received from G. E. Coe.
SP 621104-0	mm	+	++	Open-pol. var. derived by mass sel. from the cross, SL 539 CTR mm x [CTR MM x (CTR MM x US 201 MM)].
<u>Other material:</u>				
SL 122 MS x) SP 5460-0)	m	+	++	WC 2433; commercial hybrid; furnished by F & M and West Coast Beet Seed Co.
SL 126 MS x) SP 5460-0)	m	+	++	WC 2371; commercial hybrid; furnished by F & M and West Coast Beet Seed Co.
SP 621000-0	mm	++	-	Sel. from SP 591101-0 (see above).
SP 621160-00	mm	++	-	Derived from the cross, SP 591101-0 mm x Botrytis res. sel. from SP 5481-0 MM.

a/ Rough classification with respect to leaf spot resistance (LSR) and curly top resistance (CTR), based on various sources of information and on personal opinion: +++ = good; ++ = fairly good; + = fair to medium; ± = slight if any; - = none; -? = probably none.

TOP-CROSS TEST, FT. COLLINS, COLORADO, 1963
Experiment No. 2A

Conducted by: J.A. Elder and J.O. Gaskill (Also see "Note", below, regarding curly top resistance evaluation by A.M. Murphy).

Location: Hospital Farm, Ft. Collins, Colorado; field no. 4.

Cooperation: Colorado Agricultural Experiment Station, National Sugar Manufacturing Company, Beet Sugar Development Foundation, and Board of County Commissioners of Larimer County.

Dates of Planting and Harvest: April 19-22; October 7.

Experimental Design: Randomized-block; 7 replications; plots 1 row x 22'; rows 20" apart; hand thinned to single-plant hills.

Determination of Root Yield: With minor exceptions, all roots in 19' of row in each plot were hand topped, washed, and weighed.

Determination of Sucrose Percentage: All roots harvested for root yield determination in each plot constituted one sample for sucrose analysis. Duplicate sucrose determinations were made for the composited pulp from each sample.

Stand: Good.

Recent Cropping History: 1960 and 1961, alfalfa; 1962, barley.

Chemicals Applied for Sugarbeet Crop: Treble superphosphate (approximately 225 lbs. per acre) and ammonium nitrate (approximately 82 lbs. per acre) were applied in September, 1962, just before plowing. Shell DD (about 42 gal. per acre) was applied in September, 1962, for sugarbeet nematode control.

Leaf Spot Exposure: Severe; prolonged.

Curly Top Exposure: Negligible.

Yellows Virus: Yellows (presumably "western") was rather general throughout the field; effects mild.

Other Diseases & Pests: Negligible.

Soil and Seasonal Conditions: The 1963 crop season was hot and dry on the whole. A heavy rain about September 20 and unusually warm fall weather were conducive to growth and unfavorable for sucrose accumulation. Adequate soil moisture was maintained throughout the season by means of furrow and sprinkler irrigations. Inoculation (July 2) and subsequent frequent sprinkling were employed in order to promote the development of leaf spot (*Cercospora beticola*).

Reliability of Test: Good.

* * * * *

Note: The above information pertains entirely to the #2A Top-Cross Test at Ft. Collins, Colorado. Curly top resistance evaluation, as shown in the table of results, was performed by A.M. Murphy at Thatcher, Utah, by means of field plots in which the development of curly top was promoted artificially. Most lines and hybrids were represented by a single plot, 1 row x 50' in size.

* * * * *

TOP-CROSS TEST, FT. COLLINS, COLORADO, 1963 (EXP. NO. 2A)

		Pollinators a/					Check vars. (mono.) a/		Misc. (mm, LSR-BRR) a/								
		♀		MM		mm		Aver. b/		SL		SL		SP		SP	
Attribute	Performance of	(CMS of mm lines below)	CTR		LSR-CTR		LSR-BRR		of hybrids	122 MS		126 MM		621000		621160	
			SL	SP	SL	SP	SL	SP		x SP	x SP	-0	-00				
Roots per acre (tons)	Pol., etc.		932	6051-0	59B18-0	5481-0	591101-0		5460-0	5460-0					16.27	16.75	
				14.09		15.82	16.26		13.33	15.34							
	Hybrids	FC 501 (1)	15.90	15.84	18.82												
	"	FC 503 (2)		16.39													
	"	SP 561609-0 (3)			13.13												
	"	SP 561606-0 (4)	15.42	15.77	16.36	14.51	16.00	15.61									
	"	SP 581179sl (5)	13.97	14.81	20.06	15.96	17.50	16.46									
	"	SP 581181sl (6)	16.44	17.13	18.68	17.09	16.77	17.22									
	"	SP 581222sl (7)	15.70	16.39	19.41	16.91	17.14	17.11									
	"	Av. 4-7 g/	15.38	16.03	18.63	16.12	16.85										
			LSD g/ (1) = 1.90; (2) = 0.95; (3) = 0.85														
Sucrose (%)	Pol., etc.			11.63		12.26	13.39		12.46	12.39	12.71	13.54					
	Hybrids	FC 501 (1)	13.30	13.04	13.13												
	"	FC 503 (2)		13.52													
	"	SP 561609-0 (3)			14.12												
	"	SP 561606-0 (4)	12.66	12.56	13.66	12.39	12.77	12.81									
	"	SP 581179sl (5)	13.36	12.88	13.74	12.52	13.62	13.22									
	"	SP 581181sl (6)	13.57	13.46	14.13	13.54	13.06	13.55									
	"	SP 581222sl (7)	13.84	13.79	14.13	13.61	13.18	13.71									
	"	Av. 4-7 g/	13.36	13.17	13.92	13.02	13.16										
			LSD g/ (1) = 0.85; (2) = 0.42; (3) = 0.38														
Gross sucrose per acre (lbs.)	Pol., etc.			3328		3903	4383		3353	3827	4150	4532					
	Hybrids	FC 501 (1)	4228	4136	4953												
	"	FC 503 (2)		4451													
	"	SP 561609-0 (3)			3715												
	"	SP 561606-0 (4)	3903	3970	4485	3608	4097	4013									
	"	SP 581179sl (5)	3752	3824	5528	4010	4791	4381									
	"	SP 581181sl (6)	4478	4605	5280	4654	4384	4680									
	"	SP 581222sl (7)	4347	4518	5497	4597	4525	4697									
	"	Av. 4-7 g/	4120	4229	5198	4217	4449										
			LSD g/ (1) = 639; (2) = 320; (3) = 286														
Leaf g/spot grade (8/28)	Pol., etc.			4.9		3.4	2.9		5.4	4.4	2.7	3.1					
	Hybrids	FC 501 (1)	4.9	3.4	2.9												
	"	FC 503 (2)		4.5													
	"	SP 561609-0 (3)			6.0												
	"	SP 561606-0 (4)	5.6	5.0	4.4	4.5	4.3	4.8									
	"	SP 581179sl (5)	6.1	4.9	4.4	4.9	3.3	4.7									
	"	SP 581181sl (6)	4.9	4.1	3.5	3.6	3.1	3.8									
	"	SP 581222sl (7)	5.4	4.6	4.1	3.7	3.9	4.3									
	"	Av. 4-7 g/	5.5	4.7	4.1	4.2	3.7										
Curly f/ top grade (Thatcher, Utah)	Pol., etc.		3.5(F ₂)	4													
	Hybrids	FC 501 (1)	4	5													
	"	FC 503 (2)	6	4.5													
	"	SP 561609-0 (3)															
	"	SP 561606-0 (4)	4	5													
	"	SP 581179sl (5)	4	4													
	"	SP 581181sl (6)	4	4													
	"	SP 581222sl (7)	4	4													

a/ Basic data presented as 7-plot averages, except curly top.

b/ 35-plot averages.

c/ 28-plot averages (hybrids of CMS lines 4-7, inclusive).

d/ LSD (5% point) for comparisons between: (1) 7-plot averages; (2) 28-plot averages; and (3) 35-plot averages.

e/ Leaf spot grades (J. A. Elder): 0 = no leaf spot; 10 = complete defoliation.

f/ Curly top grades (Thatcher, Utah; A.M. Murphy; moderate curly top exposure; mostly single-plot readings; end of October, 1963): 0 = healthy; 9 = dead due to curly top. Grades for checks were as follows: SL 202 H9, 2; US 41, 3; US 33, 5.3; SP 5481-0, 6.

TOP-CROSS TEST, FT. COLLINS, COLORADO, 1963
Experiment No. 3A

Conducted by: J.A. Elder and J.O. Gaskill (Also see "Note", below, regarding curly top resistance evaluation by A.M. Murphy).

Location: Hospital Farm, Ft. Collins, Colorado; field no. 4.

Cooperation: Colorado Agricultural Experiment Station, National Sugar Manufacturing Company, Beet Sugar Development Foundation, and Board of County Commissioners of Larimer County.

Dates of Planting and Harvest: May 6-7; October 15.

Experimental Design: Equalized-random-block, 24 x 8; plots 1 row x 20'; rows 20" apart; hand thinned to single plant hills.

Determination of Root Yield: With minor exceptions, all roots in 17' of row in each plot were hand topped, washed, and weighed.

Determination of Sucrose Percentage: All roots harvested for root yield determination in each plot constituted one sample for sucrose analysis. Duplicate sucrose determinations were made for the composited pulp from each sample.

Stand: Good.

Recent Cropping History: 1960 and 1961, alfalfa; 1962, barley.

Chemicals Applied for Sugarbeet Crop: Treble superphosphate (approximately 225 lbs. per acre) and ammonium nitrate (approximately 82 lbs. per acre) were applied in September, 1962, just before plowing. Shell DD (about 42 gal. per acre) was applied in September, 1962, for sugarbeet nematode control.

Leaf Spot Exposure: Severe.

Curly Top Exposure: Negligible.

Yellows Virus: Yellows (presumably "western") was rather general throughout the field; effects mild.

Other Diseases and Pests: Negligible.

Soil and Seasonal Conditions: The 1963 crop season was hot and dry on the whole. A heavy rain about September 20 and unusually warm fall weather were conducive to growth and unfavorable for sucrose accumulation. Adequate soil moisture was maintained throughout the season by means of furrow and sprinkler irrigations. Inoculation (July 2) and subsequent frequent sprinkling were employed in order to promote the development of leaf spot (Cercospora beticola).

Reliability of test: Good.

* * * * *

Note: The above information pertains entirely to the #3A Top-Cross Test at Ft. Collins, Colo. Curly top resistance evaluation, as shown in the table of results, was performed by A.M. Murphy at Thatcher, Utah, by means of field plots in which the development of curly top was promoted artificially. Most lines and hybrids were represented by a single plot, 1 row x 50' in size.

* * * * *

Attri- bute	Pol. & cks.	♀ (LSR, 2n, mm; ance of CMS of lines below)	Pollinators (CTR ±) a/				Check vars. (mono.) b/			
			SL	SP	2n	mm	multi.	Aver. b/	SL	SP
Roots per acre (tons)			932	6051-0	581813-00	621104-0	62-16	(2n hybs: SL 122 MS: SL 126 MS: only)	SP 5460-0	SP 5460-0
			(LSR)	(LSR)	(LSR)	(LSR)	(LSR)			
			12.81	12.51	10.44	12.66			11.78	12.86
			13.31	12.41	13.71	13.12	14.44		13.14	
			13.33	12.75	15.05	12.09	14.70		13.31	
			13.56	12.65	12.94	12.62			12.94	
			16.91	13.94	17.03	13.25			15.28	
			14.28	12.94	14.68	12.77				
			LSD c/; (1) = 1.25; (2) = 0.63							
			12.46	12.83	12.19	12.78			11.95	12.92
			14.40	14.69	14.83	13.93	14.54		14.46	
			14.05	13.34	13.29	13.26	13.20		13.49	
			13.96	13.42	14.00	13.33			13.68	
			13.58	12.48	13.18	13.34			13.15	
			14.00	13.48	13.83	13.47				
			LSD c/; (1) = 0.68; (2) = 0.34							
			3211	3196	2549	3250			2819	3315
			3845	3636	4070	3688	4201		3810	
			3750	3404	3996	3212	3873		3591	
			3783	3406	3632	3357			3545	
			4592	3507	4487	3532			4030	
			3993	3488	4046	3447				
			LSD c/; (1) = 4.11; (2) = 205							
			4.2	3.4	4.5	4.5			5.4	5.0
			4.9	3.4	2.8	3.4	3.9		3.6	
			5.2	4.0	3.4	3.9	3.9		4.1	
			5.8	3.5	3.5	3.8			4.2	
			4.1	3.5	2.6	3.2			3.4	
			5.0	3.6	3.1	3.6				
			3.5 (F2)	4	5	4	4			
			6	4.5	6	6	4			
			5	5	6	5				
			4	5	5	4				

a/ Basic data presented as 8-plot averages, except curly top.

b/ 32-plot averages.

c/ LSD (5% point): (1) for comparison of 8-plot averages; (2) for comparison of 32-plot averages.

d/ Leaf spot grades (J.A. Elder): 0 = no leaf spot; 10 = complete defoliation.

e/ Curly top grades (Thatcher, Utah; A.M. Murphy; moderate curly top exposure; mostly single-plot readings; end of October, 1963): 0 = healthy; 9 = dead due to curly top. Grades for checks were as follows: SL 202 H9, 2; SL 41, 3; US 33, 5.3; SP 5481-0, 6. The grade for the type-0 phase of each line is shown in parentheses following the line no.

Development of Monogerm, Type-0, LSR-CTR, Inbred Lines

The following B₂ material was produced at Ft. Collins, during a period of several years, to serve as a basis for selection of monogerm, type-0 lines having resistance to both leaf spot and curly top:

$$\begin{array}{c} \text{SLC 122-0 (mm CTR)} \\ \times \\ \left[\begin{array}{c} \text{US 22/4 and SL 202 (MM CTR)} \\ \times \\ \text{US 22/3 (MM CTR) x US 201 (MM LSR)} \end{array} \right] \end{array}$$

US 201, the non-recurring parent, served as the source of leaf spot resistance, and field selection under leaf spot conditions was employed in successive generations in an attempt to retain a high level of resistance. Monogerm segregants, carrying the cytoplasm of SLC 122-0, were selected from an increase of the B₂ and grouped to produce a seed lot designated SP 611100-0. Monogerm segregants from a backcross similar to the above, but with cytoplasm derived from the multigerm variety, SL 202, were grouped to produce SP 611101-0. Staked (LSR) plants, selected in both of the "61" numbers, were selfed and indexed for the type-0 character in 1962. Twenty of the original selfed seed lots were shared with Dr. C. W. Bennett, Salinas, California, early in 1963 for CTR evaluation and a portion of each lot was planted on the Hospital Farm at Ft. Collins for LSR evaluation.

As may be observed in the accompanying table, at least 10 of the lines with a perfect "0-rating" (100/0) or nearly so (90/0 or better) were approximately equal to US 75 in CTR and to SP 5481-0 in LSR. The relatively high frequency of occurrence of the combination of the type-0 character with LSR and CTR in this material is very encouraging.

EVALUATION OF LEAF SPOT AND CURLY TOP RESISTANCE OF NEW,
MONOGERM, TYPE-O AND NEAR TYPE-O S₁ LINES, 1963

Ft. Collins, Colorado, and Salinas, California

Immediate : parent : or de- : scription :	Strain no.	:Pol-a/ :len : O- b/ :rat- : rat- :ing : ing	: CTR evaluation g/ :No. : Aver.: : Code : inf. : C T : try : : no. : plants: grade: no. : plots:	: LSR evaluation g/ :En- : No. : : LS grade : : 8/15: 8/23: 8/30: 8/15 :	: Vig.e/ :							
<u>Set I for CTR Evaluation</u>												
SP 611100-0	SP 622012s1	5	100/0	63-1	31	3.5	403	2	2.5	4.0	4.8	4.0
do	SP 622027s1	5	100/0	63-2	34	3.3	406	2	0.5	1.0	1.8	5.5
do	SP 622050s1	5	72/17	63-3	35	3.4	408	1	1.0	1.5	2.0	5.0
do	SP 622073s1	1	90/0	63-4	31	3.0	415	1	1.0	1.0	2.0	8.0
do	SP 622078s1	1	100/0	63-5	27	2.6	419	1	2.5	3.0	3.0	6.0
do	SP 622079s1	5	70/0	63-6	32	3.5	421	1	4.0	5.0	5.0	4.0
do	SP 622091s1	5	87/0	63-7	37	3.0	426	1	2.0	3.5	4.0	6.0
do	SP 622106s1	5	100/0	63-8			430	2	1.0	2.8	3.8	5.0
do	SP 622107s1	5	100/0	63-9	33	3.4	432	1	1.5	2.5	3.5	5.0
do	SP 622108s1	1	90/0	63-10	36	2.4	434	2	1.0	2.3	2.8	6.5
CTR check	US 75				35	3.2						
<u>Set II for CTR Evaluation</u>												
SP 611100-0	SP 622112s1	5	90/0	63-11	36	3.2	438	2	1.3	1.5	3.0	5.0
do	SP 622115s1	1	91/0	63-12	38	3.3	440	2	1.8	2.3	2.8	6.5
do	SP 622116s1	5	95/0	63-13	36	2.6	442	1	1.5	3.0	3.0	5.0
do	SP 622120s1	5	100/0	63-14	35	3.6	444	2	3.5	5.0	5.5	5.0
SP 611101-0	SP 622067s1	5	90/0	63-15	36	3.0	446	1	1.0	2.5	2.5	4.0
do	SP 622068s1	5	86/0	63-16	16	3.6	447	1	0.5	1.0	1.0	3.0
do	SP 622071s1	3	100/0	63-17	33	2.9	449	1	1.0	1.0	1.0	6.0
do	SP 622101s1	5	100/0	63-18	35	2.6	453	1	2.0	3.0	3.0	6.0
do	SP 622114s1	5	95/0	63-19	36	3.1	456	1	4.0	6.0	5.0	4.0
do	SP 622119s1	5	79/11	63-20	35	3.2	458	2	2.0	2.8	4.0	5.5
CTR Check	US 75				37	3.6						
<u>Checks for LSR Evaluation</u>												
US 201	SP 581001-0						498	6	0.8	1.0	1.4	6.2
SP 5481-0	Acc. 2483						499	8	1.4	2.2	2.8	7.3
Syn. Check	Acc. 2269						500	6	4.7	5.6	6.0	5.0

a/ Quantity of pollen shed by the individual plant that was selfed to produce the indicated strain no.; grades 1 - 5 in ascending order of abundance.

b/ Pertains to the indexing population (usually about 20 plants); left number is percentage classed as male sterile; right number is percentage classed as male fertile; percentage unaccounted for, if any, represents intermediate types.

c/ Curly top resistance evaluation by C.W. Bennett, Salinas, Calif., using greenhouse seedling technique with curly top virus strain 11; curly top grades 1 - 5 in ascending order of severity. The plants were classified individually, and noninfected plants were disregarded in computing averages.

d/ Leaf spot resistance evaluation by J.A. Elder in field plots (Experiment 6A) on Hospital Farm, Ft. Collins, Colo.; plots 1 row x 19' flanked by a susceptible strain; inoculation and frequent sprinkling used to promote leaf spot development. Basis of grades: 0 = no leaf spot; 10 = complete defoliation.

e/ Foliage vigor: larger no. = greater vigor.

Cooperative Evaluation Tests of LSR-CTR Varieties

Seed supplies described in an accompanying table were assembled at Ft. Collins and distributed to cooperators for evaluation. A partial set was furnished for 1 test. For all others, complete sets of 7 varieties were supplied. One or 2 "local-check" varieties were furnished for each test by the cooperator. Tests completed by the end of November were as follows:

<u>State</u>	<u>Locality</u>	<u>Type of test</u>	<u>Organization conducting test</u>
Calif.	Hamilton City	Agron.	Holly Sugar Corp.
Colo.	Ft. Collins	Agron.	U.S. Dept. of Agriculture
Colo.	Rocky Ford	Agron.	American Crystal Sugar Co.
Kan.	Tribune	Agron.	Kansas Agr. Exp. Station and the National Sugar Mfg. Co.
Md.	Beltsville	Agron.	U.S. Dept. of Agriculture
N.M.	Artesia	Agron.	N.M. Agr. Exp. Station
Okla.	Goodwell	Agron.	Okla. Agr. Exp. Station
Texas	Hereford	Agron.	Holly Sugar Corp.
Utah	Thatcher	Observ.	U.S. Dept. of Agriculture

Results for the individual tests are presented in separate tables. A general summary of harvest results for all agronomic tests, except for that with the incomplete set of varieties, is given in a single table in which averages are shown as percentages of those obtained for variety no. 1 (SL 122 MS x SP 5460-0), a monogerm hybrid serving as the standard.

The 1963 results confirmed the finding reported for 1962 regarding the superiority of the monogerm hybrid, SL 126 MS x SP 5460-0, compared with SL 122 MS x SP 5460-0. Based on all tests providing gross sucrose data, the former hybrid exceeded the latter in gross sucrose yield, each year, by 11%. This difference was largely due to the superior root yielding ability of SL 126 MS x SP 5460-0. Differences between the 2 varieties in sucrose percentage were negligible in 1962. In 1963 the sucrose percentage of SL 126 MS x SP 5460-0 was significantly higher than that of SL 122 MS x SP 5460-0 in 1 test. Averages for the 2 varieties, based on the other 5 tests, were nearly identical. The 2 varieties differ very little in resistance to leaf spot and curly top (2 years' results). For 1962 results, see p. 145, Sugarbeet Research, 1962 Report.

The 2 triploid monogerm hybrids, entries 4 and 5, were about equal to SL 126 MS x SP 5460-0 in gross sucrose yield in 1963.

The severe curly top exposure at Artesia, New Mexico, in 1963^{1/} emphasizes the importance of curly top in that area. It also should be recalled that even more severe curly top exposure has been observed at Hereford, Texas, within the last 10 years, exposure so intense that the susceptible check in a variety test yielded less than 1 ton of roots per acre in contrast with 20 tons for the CTR check (US 22/3).

Leaf spot was an important factor in several of the agronomic tests in 1963, but the test at Artesia was the only one where both leaf spot and curly top were important. Under these conditions, the multigerm, LSR-CTR variety, SP 6051-0, was strikingly superior to all other varieties in vigor and relative freedom from disease.^{2/} That variety was the highest in final yield of roots (58.3 tons per acre), being 43% above SL 122 MS x SP 5460-0. Additional results for SP 6051-0 appear in Sugarbeet Research-1961 Report, pages 122-132, and also in the current (1963) issue of Sugarbeet Research under the heading, "Top-cross Tests" (Ft. Collins Experiments 2A and 3A), where combining ability data are presented.

1/ For results, see pages 205-207.

2/ Photo, page 208.

COOPERATIVE AGRONOMIC EVALUATION TESTS OF LSR-CTR VARIETIES, 1963

Description of Varieties

Entry: Ft. Collins:

no. :	seed no. :	Description and supplier
1	Acc. 2528	SL 122MS x SP 5460-0; monogerm; LSR-CTR; Farmers and Manufacturers Beet Sugar Assoc. and West Coast Beet Seed Co. (W.C. lot 2433).
2	Acc. 2529	SL 126 MS x SP 5460-0; monogerm; LSR-CTR; F. & M. and West Coast Beet Seed Co. (W.C. lot 2371).
3	Acc. 2530	F61-562HO (MS) x SP 5460-0; monogerm; LSR-CTR; F. & M. and West Coast Beet Seed Co. (W.C. lot 2401).
4	Acc. 2531	SL 126 MS x US 401 4n; monogerm; LSR-CTR; F. & M. and West Coast Beet Seed Co. (W.C. lot 2362).
5	Acc. 2532	F61- 562HO (MS) x US 401 4n; monogerm; LSR-CTR; F. & M. and West Coast Beet Seed Co. (W.C. lot 2361).
6	Acc. 2533	SP 5822-0; a U.S.D.A., leaf spot-black root resistant, multigerm variety developed for eastern sugar-beet areas; included in these cooperative tests as an LSR check; seed furnished by the Great Western Sugar Co.
7	Acc. 2534	2539H1; (515 HO x 569) x NB7; a U.S.D.A., bolting resistant, curly top resistant, monogerm hybrid developed for use in California; included in these tests as a CTR check; seed furnished by the Union Sugar Division (through J.S. McFarlane, U.S.D.A., Salinas, California).
8		Local check, furnished by cooperator.
9		Local check, furnished by cooperator (occasional use).

COOPERATIVE AGRONOMIC EVALUATION TESTS OF LSR-CTR VARIETIES, 1963
General Summary of Harvest Results ^{a/}
(Averages expressed as percentages of those obtained for SL 122 NS x SP 5460-0)

Description	Disease exposure ^{c/}	Gross sucrose yield							Root yield							Percent sucrose						
		En-try no.							F.C. : R.F. : Trb. : Her. : Art. : D. : H.C. : Del.							F.C. : R.F. : Trb. : Her. : Art. : D. : H.C. : Del.						
		: try no. :							Col. : Col. : Kan. : Tex. : N.M. : Cal. : Md. :							Col. : Col. : Kan. : Tex. : N.M. : Cal. : Md. :						
		1	2	3	4	5	6	7	LS : LS :	LS : LS :	LS : LS :	LS : LS :	LS : LS :	LS : LS :	LS : LS :	(1) : (2) :	(1) : (2) :	(3) : (3) :	(4) : (4) :	(5) : (5) :	(6) : (6) :	(6) : (6) :
SL 122 NS x		1	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
SP 5460-0; mono.																						
SL 126 NS x		2	118	130	103	105	99		112	119	100	106	113	103	114	106	109	103	99	97	95	
SP 5460-0; mono.																						
F61-562HO NS x		3	108	124	105	103	77		109	108	103	107	95	83	116	100	115	103	96	94	92	
SP 5460-0; mono.																						
SL 126 NS x		4	118	118	101	105	113		113	113	107	107	127	115	108	104	104	94	98	92	99	
US 401 4n; mono.																						
F61-562HO NS x		5	124	105	119	110	109		115	102	123	116	118	120	132	108	102	97	95	95	91	
US 401 4n; mono.																						
SP 5822-0; LSR		6	132	139	99	109	83		119	107	98	100	46	87	138	110	130	102	109	102	95	
check; multi.																						
2539H1; CTR		7	78	81	91	89	104		91	91	101	103	109	106	67	86	89	90	86	81	98	
check; mono.																						
Local check ^{d/}		8	149	132	120	122			130	109	126	143	118	101		115	121		95	91	103	
Local check ^{d/}		9	120	100					92	99						130		101				
L.S.D. (5% point)			11	23	19	9	8		7	19	15	6	21	4	17	6	10	7	7	9	8	

^{a/} Location of tests: (1) Ft. Collins, Colo.; (2) Rocky Ford, Colo.; (3) Tribune, Kan.; (4) Hereford, Texas; (5) Artesia, N.M.; (6) Hamilton City, Calif.; (7) Beltsville, Md.

^{b/} Artesia, N.M.: November-21 harvest results; refractometer percentages used instead of sucrose percentages.

^{c/} Disease exposure considered important: BR = black root; CT = curly top; LS = Cercospora leaf spot.

^{d/} Local check: (1) GW 674-56C; (2) entry 8 = Amer. #2 multi., entry 9 = Amer. #2 mono.; (3) deleted; (4) entry 8 = HH 10, entry 9 = HH 12; (5) SP 6051-0; (6) NBH1; (7) SP 622-0.

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
Experiment No. 1A, Ft. Collins, Colorado

Conducted by: J. A. Elder and J. O. Gaskill

Location: Hospital Farm, Ft. Collins, Colorado; field no. 4

Cooperation: Colorado Agricultural Experiment Station, National Sugar Manufacturing Company, Beet Sugar Development Foundation, and Board of County Commissioners of Larimer County.

Dates of Planting and Harvest: April 22; October 9.

Experimental Design: Latin Square, 8 x 8; plots 2 rows x 22'; rows 20" apart; hand thinned to single-plant hills.

Determination of Root Yield: All roots in both rows x 19' of each plot were hand topped, washed, and weighed.

Determination of Sucrose Percentage: All roots harvested for root yield determination in each plot were divided into 2 samples for sucrose analyses. Duplicate sucrose determinations were made for the composited pulp from each sample.

Stand and Bolter Counts: For stand, all hills were counted in each plot on September 18 in the area to be harvested for root yield. Bolter percentages were determined by counts (entire plots) in mid-season, before seed matured. Seedstalks were cut off at that time.

Recent Cropping History: 1960 and 1961, alfalfa; 1962, barley.

Chemicals Applied for Sugarbeet Crop: Treble superphosphate (approximately 225 lbs. per acre) and ammonium nitrate (approximately 82 lbs. per acre) were applied in September, 1962, just before plowing. Shell DD (about 42 gal. per acre) was applied in September, 1962, for sugarbeet nematode control.

Leaf Spot Exposure: Severe; prolonged; first extensive "burning" or "blighting" of leaves occurred early in August.

Curly Top Exposure: Negligible.

Yellows Virus: Yellows (presumably "western") was rather general throughout the field; effects mild.

Other Diseases and Pests: Negligible.

Soil and Seasonal Conditions: The 1963 crop season was hot and dry on the whole. A heavy rain about September 20 and unusually warm fall weather were conducive to growth and unfavorable for sucrose accumulation. Adequate soil moisture was maintained throughout the season by means of furrow and sprinkler irrigations. Inoculation (July 2) and subsequent frequent sprinkling were employed in order to promote the development of leaf spot (Cercospora beticola).

Reliability of Test: Good.

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
Experiment No. 1A, Ft. Collins, Colorado
(Results given as 8-plot averages)

Description	Ft. Col. : : seed : no.	Entry : : no.	Acre yield		Roots	Sugar		Leaf Spot		Stand : : Hills : Bolters
			Gross : : Lbs.	sucrose : : Tons		Sucrose : : %	8/13 : : 8/21	8/28 : : 8/13	Vigor : : 8/13	
SL 122 MS x SP 5460-0; mono.	Acc. 2528	1	3672	14.80		12.38	3.6	4.4	5.4	6.1
SL 126 MS x SP 5460-0; mono.	Acc. 2529	2	4351	16.56		13.12	2.9	4.0	5.1	6.6
F61-562HO MS x SP 5460-0; mono.	Acc. 2530	3	3967	16.06		12.33	2.4	2.9	3.8	6.8
SL 126 MS x US 401 4n; mono.	Acc. 2531	4	4337	16.79		12.92	3.3	4.6	5.4	6.8
F61-562HO MS x US 401 4n; mono.	Acc. 2532	5	4550	17.06		13.33	2.9	4.0	4.9	7.1
SP 5822-0; multi.; LSR check	Acc. 2533	6	4842	17.66		13.66	1.3	1.8	2.5	6.5
2539 H1; mono.; CTR check	Acc. 2534	7	2848	13.40		10.61	5.8	6.5	7.5	3.9
GW 674-560; multi.; local check	Acc. 2168	8	5475	19.19		14.26	2.3	3.2	4.5	6.8
General mean			4255.22	16.4405		12.8263				
S.E. of var. mean			135.95	0.3578		0.2431				
S.E. of var. mean as % of gen. mean			3.19	2.18		1.90				
L.S.D. (5% point)			388	1.02		0.69				

Variance Table

Source of Variation	D/F	Mean Square (variance)			
		Gross	Sucrose	Roots	Sucrose %
Rows	7	840,970.7		4,9020	2.4486
Columns	7	289,341.4		1,6568	0.9808
Varieties	7	4,959,462.1		24,7039	9.6369
Error (remainder)	42	147,862.9		1,0243	0.4730
Total	63				
Calculated F value		33.54**		24.12**	20.37**

a/ Leaf spot: 0 = no leaf spot; 10 = complete defoliation.

b/ Foliage vigor: larger no. = greater vigor.

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
Rocky Ford, Colorado

Conducted by: American Crystal Sugar Company.

Location: Rocky Ford, Colorado.

Dates of Planting and Harvest: April 10; October 8.

Experimental Design: Triple Lattice, repeated 3 times, 9 replications;
plots 1 row x 35'; rows 22" apart.

Determination of Root Yield: Complete plot.

Determination of Sucrose Percentage: Approximately one-half of the
beets per plot were bulked as one sample.

Stand Counts: Harvested beets counted when weighed.

Recent Cropping History: Alfalfa.

Fertilizer Applied for Sugarbeet Crop: 800 pounds of 18-46-0.

Leaf Spot Exposure: Moderate.

Curly Top Exposure: Light.

Other Diseases and Pests: Negligible.

Soil and Seasonal Conditions: Season extremely dry, beets suffered
from drought a couple of times.

Reliability of Test: Fair.

Rocky Ford, Colorado

(Results given as 9-plot averages)

Variance Table b/

Source of Variation	D.F.	Roots (lbs.)	Mean Square (variance)	%:Sucrose	No. Roots	(35')
Replicates	8	58.9312	0.9838		165.750	
Component (a)	12	109.5391	1.4242		36.583	
Component (b)	6	261.4116	0.3250		13.833	
Blocks	18	160.1633	1.0577		29.000	
Varieties	8	221.6600	17.7162		69.375	
Error (Intra-Block)	46	100.1691	1.1132		23.326	
Error (Random Block)	64		1.0976			
Total	80	121.6931	2.7481		39.500	

a/ Leaf spot readings (9/17/63,
J.O. Gaskill): 0 = no leaf spot;
10 = complete defoliation.

b/ For gross sucrose:

$$\text{SE lbs. sucrose} = \text{mean lbs. sucrose} \times$$

$$\frac{(\text{SE lbs.beets})^2}{(\text{mean lbs.beets})} + \frac{(\text{SE \% sucrose})^2}{(\text{mean \% suc.})}$$

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
Tribune, Kansas

Conducted by: Roy E. Gwin, Jr., and Henry Wolfe.

Location: Tribune Branch Station, Kansas Agricultural Experiment Station, Tribune, Kansas.

Cooperation: Kansas Agricultural Experiment Station and the National Sugar Manufacturing Company.

Date of Harvest: November 5.

Experimental Design: Latin Square, 8 x 8; plots 6 rows x 30'; rows 22" apart; hand thinned to single-plant hills. One variety was deleted due to poor stand, and the results were analyzed on a randomized-block basis.

Determination of Root Yield: All roots in 30' to 50' of row (usually 50') in each plot were topped, cleaned, and weighed.

Determination of Sucrose Percentage: All roots harvested for root yield in each plot were divided into 3 or more samples for sucrose analysis.

Stand Counts: Based on harvested roots.

Leaf Spot Exposure: Mild.

Curly Top Exposure: Negligible.

Other Diseases and Pests: Negligible.

Soil and Seasonal Conditions: High fertility; adequate irrigation; warm fall weather, unfavorable for sucrose accumulation.

Reliability of Test: Variability was greater than usual in this test, especially in yield of roots and gross sucrose. According to the "F" test ($F = 1.68$), varieties did not differ significantly in gross-sucrose yield, and consequently the L.S.D. value shown for gross sucrose (1422) should be used with caution.

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963

Tribune, Kansas

(Results given as 8-plot averages)

Description	: Ft. Col. :		: Acre Yield :		: Stand :	
	: seed :	: Entry :	: Gross :	: Roots :	: Sucrose :	: (Beets per 100):
	: no. :	: no. :	: sucrose :	: Tons :	: % :	: No. :
SL 122 MS x SP 5460-0; mono.	Acc. 2528	1 a/	7599	26.86	14.04	113
SL 126 MS x SP 5460-0; mono.	Acc. 2529	2	7856	26.99	14.51	137
F61-562HO MS x SP 5460-0; mono.	Acc. 2530	3 a/	8016	27.62	14.40	113
SL 126 MS x US 401 4n; mono.	Acc. 2531	4	7685	28.70	13.20	121
F61-562HO MS x US 401 4n; mono.	Acc. 2532	5	9048	32.93	13.68	106
SP 5822-0; multi.; LSR check	Acc. 2533	6	7509	26.34	14.30	107
2539H1; mono.; CTR check	Acc. 2534	7	6934	27.20	12.58	114
General mean			7806.73	28.0905	13.8145	
S.E. of var. mean			497.63	1.3697	0.3562	
S.E. of var. mean as % of gen. mean			6.37	4.88	2.58	
L.S.D. (5% point)			14.22	3.91	1.02	

Variance Table

Source of Variation	: D/F :	: Mean Square (Variance) :	
		: Gross sucrose :	: Sucrose % :
Replications	7	5,807,540.6	21.0079
Varieties	6	3,328,658.2	40.8576
Error (remainder)	40	1,981,058.3	15.0075
Total	53		
Calculated F value		1.68	2.72*
			4.00**

a/ The data for one plot were missing, and results for that plot were estimated, using the method of Allen and Wishart.

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
Hereford, Texas

Conducted by: D. F. Peterson, W. S. Fisher, et al.

Location: Reinauer Farm near Hereford, Texas.

Cooperation: Holly Sugar Corporation; Eddie Reinauer, grower.

Dates of Planting and Harvest: March 29; September 26.

Experimental Design: Latin Square, 9 x 9; plots 2 rows x 54'; rows 30" apart.

Determination of Root Yield: All roots in 2 rows x 50' in each plot were weighed for yield determination.

Determination of Sucrose Percentage: Two 10-beet samples from each plot.

Leaf Spot Exposure: Severe

Curly Top Exposure: Negligible

Other Diseases and Pests: Negligible

Soil and Seasonal Conditions: High fertility; good uniformity; irrigation adequate.

Reliability of Test: An excellent test in all respects; data very reliable.

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
Hereford, Texas

(Results given as 9-plot averages)

Description	:Ft. Col. :		: Entry :		: Acre Yield :		: Roots :		: Sucrose :		: Leaf a/ :		: Stand :	
	: seed	: no.	: no.	: no.	: Gross	: Lbs.	: sucrose:	: Tons	: %	: spot	: (Beets	: (per 100')	: No.	
SL 122 MS x SP 5460-0; mono.	Acc.	2528	1		4646	18.996			12.23	4.8			154	
SL 126 MS x SP 5460-0; mono.	Acc.	2529	2		4874	20.073			12.14	4.2			161	
F61-562HO MS x SP 5460-0; mono.	Acc.	2530	3		4778	20.331			11.75	4.2			157	
SL 126 MS x US 401 4n; mono.	Acc.	2531	4		4864	20.318			11.97	4.6			162	
F61-562HO MS x US 401 4n; mono.	Acc.	2532	5		5111	22.108			11.56	4.2			157	
SP 5822-0; multi.; LSR check	Acc.	2533	6		5044	18.975			13.29	2.2			142	
2539H1; mono.; CTR check	Acc.	2534	7		4121	19.493			10.57	8.0			162	
HH 10; local check			8		5572	23.975			11.62	4.9			165	
HH 12; local check			9		4641	18.818			12.33	5.3			155	
General mean					4850	20.343			11.94	4.7			157	
S.E. of var. mean					151 b/	0.397			0.29					
S.E. of var. mean as % of gen. mean					3.11	1.95			2.42					
L.S.D. (5% point)					428	1.128			0.82					

Variance Table

Source of Variation	: D/F :	: Mean square (variance) :	
		: Roots :	: Sucrose % :
Rows	8	6.09	3.54
Columns	8	4.60	1.59
Varieties	8	26.01	4.80
Error (remainder)	56	1.42	0.75
Total	80	4.66	1.52
Calculated F value		18.31**	6.40**

a/ Leaf spot grades: scale of 1 to 10 in ascending order of severity.

b/ S. E. of var. mean calculated from formula.

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
Hamilton City, California

Conducted by: D. D. Dickenson

Location: Hamilton City, California

Cooperation: Holly Sugar Corporation; grower, Nichols.

Dates of Planting and Harvest: May 2; October 29.

Experimental Design: Latin Square, 8 x 8; plots 2 rows x 50';
rows 30" apart.

Determination of Root Yield: 2 rows x 47' harvested.

Leaf Spot Exposure: Leaf spot began about September 1 and continued until harvest. The amount at harvest was less than at earlier dates, however.

Curly Top Exposure: Negligible.

Remarks: The soil was extremely moist at harvest and top growth was very great.

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
Hamilton City, California
(Results given as 8-plot averages)

Description	: Ft. Col.:		: Acre Yield		: Leaf ^a :		: Stand :	
	: seed	: Entry:	: Gross	: No.:	: sucrose	: Roots	: Sucrose:	: (Beets
	: no.	: No.:	: sucrose	: Roots	: Sucrose:	: 10/27	: per 100'	:) :
			Lbs.		Tons	%		No.
SL 122 MS x SP 5460-O; mono.	Acc. 2528	1	5550		29.774	9.32	3.3	134
SL 126 MS x SP 5460-O; mono.	Acc. 2529	2	5470		30.733	8.90	3.1	133
F61-562HO MS x SP 5460-O; mono.	Acc. 2530	3	4255		24.798	8.58	3.4	114
SL 126 MS x US 401 4n; mono.	Acc. 2531	4	6293		34.238	9.19	2.8	142
F61-562HO MS x US 401 4n; mono.	Acc. 2532	5	6067		35.646	8.51	2.9	110
SP 5822-O; multi.; LSR check	Acc. 2533	6	4584		25.869	8.86	2.5	159
2539H1; mono.; CTR check	Acc. 2534	7	5755		31.623	9.10	4.3	157
NBH1 (12325); local check		8	6768		35.106	9.64	2.1	164
General Mean			5593		30.973	9.01	3.0	139
S.E. of var. mean			14.9b/		0.822	0.27		
S.E. of var. mean as % of gen. mean			2.66		1.74	2.96		
L.S.D. (5% point)			422		1.162	0.75		

Variance Table

Source of Variation	: D/F :		: Mean Square (variance)		: Sucrose %:	
	: 7	: 8.641	: Roots	: 2.202	: 0.391	: 1.151
Rows	7	16.480				
Columns	7	132.205				
Varieties	42	5.400				
Error (remainder)	63					
Total						
Calculated F value		24.48**		NS		

a/ Leaf spot ratings: scale 1 - 10 in ascending order of severity.

b/ Short-cut formula

** Exceeds 1% level 3.10

NS: Not significant

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
Goodwell, Oklahoma

Conducted by: H. Eugene Reeves, Bill Ott and Ralph Matlock.

Location: Panhandle Agricultural Experiment Station, Goodwell, Oklahoma.

Cooperation: Oklahoma Agricultural Experiment Station, Holly Sugar Corporation, Great Western Sugar Company, American Crystal Sugar Company, U.S.D.A. Ft. Collins, Colorado.

Dates of Planting and Harvest: March 24; October 29.

Experimental Design: Randomized block; 10 replications; plots 3 rows 21', rows 28" apart, center row test variety, 2 rows common border US-35/2; hand thinned to single plant hills 9" apart.

Determination of Root Yield: All roots in 16' of harvest row were hand topped, cleaned and weighed.

Determination of Sucrose and Thin Juice Purity Percentages: A random sample of roots was taken from the row and shipped to Holly Sugar Corporation for analysis.

Recent Cropping History: 1961 Fallow, 1962 Sesame.

Chemicals Applied for Sugar Beet Crop: 80 lbs. of N (applied as ammonium nitrate) applied on May 8 as a sidedressing.

Leaf Spot Exposure: Negligible.

Curly Top Exposure: Very mild.

Other Diseases and Pests: Mild to moderate root aphid infestation; otherwise negligible.

Soil and Seasonal Conditions: The 1963 crop season was unusually dry and fairly hot. A hail storm on July 12 completely defoliated the plants. Recovery was good. Adequate soil moisture was maintained throughout the season by means of furrow irrigation.

Reliability of Test: Good.

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
 Goodwell, Oklahoma
 (Results given as 10-plot averages)

Description	Ft. Col. :		Entry:		Acre Yield		:		:	
	: seed	: no.	: no.	: sucrose	: Gross	: Roots	: Sucrose	: Thin	: juice	: purity
					Lbs.	Tons		%		%
SL 126 MS x SP 5460-0; mono.	Acc. 2529	2	5200.02	20.11	12.70	96.89				
SL 126 MS x US 401 4n; mono.	Acc. 2531	4	5220.35	21.42	12.12	96.76				
HH 6 Sp 295 (Holly)			5236.07	20.93	12.42	96.09				
General mean			5218.81	20.82	12.41	96.58				
S.E. of variety mean			348.999	.247	.170	.284				
S.E. of var. mean as % of gen. mean			6.687	1.186	1.369	.294				

Variance Table

Source of variation	:D/F:	Mean square (variance)		and Calculated F values		:	
		Gross	: sucrose	: F	: Roots	: F : percent	: Thin juice : F : purity %
Replications	9	2,202,411.28	1.80	11.3022	1.84	4.3222	1.48 6.6133 8.16
Treatments (varieties)	2	3,266.71	.0026	4.3700	.71	2.7900	.95 1.8450 2.27
Error (remainder)	18	1,218,689.91		6.1366		2.9244	.8155
Total	29	1,440,160.43	1.18	6.4517	1.05	3.3489	1.14 2.6858 3.31

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
Artesia, New Mexico

Conducted by: W. J. Russell.

Location: Southeastern Substation, New Mexico Agricultural Experiment Station, Artesia, New Mexico.

Cooperation: New Mexico Agricultural Experiment Station.

Dates of Planting and Harvest: March 28; October 21*.

Experimental Design: Randomized complete block design with 5 replications; plots 2 rows x 25'; rows 24" apart; hand thinned to single-plant hills (about 1.5 plants per foot).

Determination of Root Yield: One 10' section (20' of row) per plot.

Refractometer Readings: Made by means of a hand sugar refractometer using pressed juice of 10 roots per plot. Readings exceeded sucrose percentages by approximately 3.0.

Stand Counts: Based on roots harvested (20' of row per plot).

Fertilizers Applied for 1963 Crop: None.

Leaf Spot Exposure: Moderately severe. ^{1/}

Curly Top Exposure: Very severe. ^{1/}

Other Diseases and Pests: Negligible.

Remarks: The plants were grown on narrow beds. The field was irrigated immediately after planting, and subsequent irrigations were made at intervals of 2 to 3 weeks, with the last application being made on October 16. Stands and soil uniformity were satisfactory.

*Note: Disease ratings and the October 21st harvest data are summarized in Table 1. Results of a supplemental harvest (November 21) are compared with the October 21st results in Table 2.

^{1/} Photo, page 208.

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
Artesia, New Mexico
(Results given as 5-plot averages)

Table 1

Description	: Ft. Col. : : seed : : no. :	: Entry: : : no. : : acre :	: Roots: : : per : : acre :	: Leaf a/ : : Refract- : : ometer :	: Spot : : 8/17 : : 9/19 :	: Curly top : : 8/17 : : 9/19 :	: Stand : : (plants : : per ft.) :
							No.
SL 122 MS x SP 5460-0; mono.	Acc. 2528	1	43.7	16.3	2.0	4.0	2.5
SL 126 MS x SP 5460-0; mono.	Acc. 2529	2	43.0	16.2	3.0	1.5	3.0
F61-562HO MS x SP 5460-0; mono.	Acc. 2530	3	31.6	14.4	2.0	8.5	5.0
SL 126 MS x US 401 4n; mono.	Acc. 2531	4	47.4	14.5	6.0	0.5	1.8
F61-562HO MS x US 401 4n; mono.	Acc. 2532	5	43.8	15.0	0.5	3.0	2.5
SP 5822-0; multi.; LSR check	Acc. 2533	6	19.0	17.3	0.5	10.0	7.3
2539H1; mono.; CTR check	Acc. 2534	7	39.1	12.8	8.0	2.0	2.5
SP 6051-0; multi.; local check	SP 621228HO	8	47.1	15.0	0.0	0.0	1.0
General mean			39.3	15.2	2.8	3.7	3.2
L.S.D. (5% point)			8.63	2.20			
L.S.D. (1% point)			11.64	2.96			
Coef. of var. (%)			16.93	11.18			

Analyses of Variance

Source of Variation	: D/F : : 4 : : 7 : : 28 : : 39 :	: Mean Square : : 8.58 : : 9.43 : : 2.88 : : 39 :	: Refractometer : : F : : 2.98* : : 3.27* : : 11.08 : : 464.76 : : 44.35 :	: Root Yield : : F : : 0.25 : : 10.48** :
Replicates				
Entries				
Error				
Total				

- a/ Leaf Spot: 0 = healthy; 10 = all leaves dead (W. J. Russell).
b/ Curly Top, 8/17: Reading of 5 or above indicates all plants seriously affected (W. J. Russell).
c/ Curly Top, 9/19: 0 = healthy; 9 = dead (C. L. Schneider, 4-plot averages).
* Significant at the 5% level. ** Significant at the 1% level.

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963
Artesia, New Mexico
(Results given as 5-plot averages)
Table 2

Description	Fort Collins seed number	Entry no.	Roots per acre		Refractometer		Stand (plants)		Mean weight	
			Tons	%	Tons	%	No.	Lbs.	No.	Lbs.
			10/21	11/21:10/21	11/21:10/21	11/21:10/21	11/21:10/21	11/21:	11/21:	11/21:
SL 122 MS x SP 5460-O; mono.	Acc. 2528	1	43.7	40.8	16.3	18.5	1.4	1.5	2.9	2.6
SL 126 MS x SP 5460-O; mono.	Acc. 2529	2	43.0	46.3	16.2	17.9	1.5	1.5	2.6	2.8
F61-562HO MS x SP 5460-O; mono.	Acc. 2530	3	31.6	38.7	14.4	17.3	1.4	1.4	2.1	2.5
SL 126 MS x US 401 4n; mono.	Acc. 2531	4	47.4	51.9	14.5	17.1	1.4	1.6	3.1	3.1
F61-562HO MS x US 401 4n; mono.	Acc. 2532	5	43.8	48.1	15.0	17.5	1.3	1.5	3.2	2.8
SP 5822-O; multi.; LSR check	Acc. 2533	6	19.0	18.6	17.3	18.9	1.2	1.3	1.3	1.4
2539 H1; mono.; CTR check	Acc. 2534	7	39.1	44.3	12.8	15.0	1.4	1.4	2.6	3.0
SP 6051-O; multi.; local ck.	SP 621228HO	8	47.1	58.3	15.0	16.9	1.4	1.5	3.2	3.6
Mean			39.3	43.4	15.2	17.4	1.4	1.5	2.6	2.7
LSD .05			8.63	8.55	2.20	1.61	n.s.	0.22	0.59	0.66
LSD .01			11.64	11.54	2.96	2.17	n.s.	0.30	0.79	0.89
Coef. Var. %			16.93	15.23	11.18	7.12	15.97	11.66	17.27	18.67



Figure 1.--Differences in curly top resistance between
sugarbeet varieties in test plots of cooperative
test of LSR-CTR varieties at State Experiment Station
near Artesia, New Mexico. September 1963
Left 2 rows - SP 6051-0; Center 2 rows - SP 5822-0.

COOPERATIVE AGRONOMIC EVALUATION TEST OF LSR-CTR VARIETIES, 1963

Beltsville, Maryland

Test conducted by G. E. Coe, U.S.D.A.
(Results given as 6-plot averages) a/

Description	: Ft. Col. :		: Roots b/ :		: Leaf Spot c/, e/ :		Stand d/ (Beets per 100')
	: seed : no.	: Entry: : no.	: per : Acre	: 8/1 :	: 8/8 :	: 8/18 :	
			Tons				No.
SL 122 MS x SP 5460-0; mono.	Acc. 2528	1	18.13	4.0	4.3	4.5	94
SL 126 MS x SP 5460-0; mono.	Acc. 2529	2	20.58	3.5	3.8	4.8	91
F61-562HO MS x SP 5460-0; mono.	Acc. 2530	3	21.00	3.5	3.7	4.2	97
SL 126 MS x US 401 4n; mono.	Acc. 2531	4	19.52	3.8	4.2	4.8	99
F61-562HO MS x US 401 4n; mono.	Acc. 2532	5	23.86	3.2	3.7	4.2	92
SP 5822-0; multi.; LSR check	Acc. 2533	6	25.11	2.8	2.8	3.2	102
2539H1; mono.; CTR check	Acc. 2534	7	12.15	5.2	5.7	6.2	91
SP 622-0; mono.; tolerant to LS and CT		8	18.33	3.3	3.7	4.3	103
General mean			19.8350				
S. E. of var. mean			1.0957				
S. E. of var. mean as % of gen. mean			5.52				
L. S. D. (5% point)			3.15				

Variance Table

Source of Variation	: D/F :		: Mean Square (variance) :	
			Tons roots per acre	
Replications	5		3.9942	
Varieties	7		94.4824	
Error (remainder)	35		7.2035	
Total	47			
Calculated F value			13.12**	

- a/ Plots 1 row x 20'; rows 24" apart; randomized-block design; 6 replications; hand thinned.
- b/ Whole plots harvested for determination of root yield.
- c/ Basis of leaf spot readings: 0 = no leaf spot; 10 = complete defoliation.
- d/ Stand counts based on roots harvested.
- e/ SP 6051-0 gave leaf spot readings of 2.5, 8/1; 2.5, 8/8; and 3.5, 8/18.

Thatcher, Utah

Test Conducted by Albert M. Murphy, U.S.D.A.

a/ Results based on two replications for each entry. Basis of curly top grades: 0 = healthy; 9 = death due to curly top.

Note: The crop was planted on June 20, and moderate curly top exposure was promoted by artificial means. Plots were 1 row x 50' in replication I and 2 rows x 50' in replication II.

P A R T VI

DEVELOPMENT OF BREEDING PROCEDURES
and
PRODUCTION OF BASIC BREEDING MATERIAL

Chemical Genetic Studies
and
Polyploidy Evaluation

Foundation Project 25

LeRoy Powers

R. J. Hecker

Research conducted in cooperation with Colorado Agricultural
Experiment Station.

PROGRESS REPORT TO THE BEET SUGAR DEVELOPMENT FOUNDATION ON THE GENETIC
AND PLANT BREEDING PHASES OF PROJECT NUMBER 25 1/, 2/, 3/, 4/

By LeRoy Powers and Richard J. Hecker

Comparative Effects of Levels of Total Nitrogen, Potassium, and Sodium
in the Petioles and in the Thin Juice on Weight Per Root, Percentage
Sucrose and Percentage Apparent Purity in Sugarbeets (*Beta vulgaris* L.)

Studies conducted (see Payne et al. 7)^{4/} to determine levels of total nitrogen, potassium, and sodium in the petioles as compared with levels of these same chemicals in the thin juice, at time of harvest, have shown that there are interactions of genotypes and material analysed. It was found that some genotypes as compared to others tended to have higher levels of the three chemicals in the petioles as compared with the thin juice of the sugarbeet (*Beta vulgaris* L.). For other comparisons the reverse was found to be true. The purpose of the study reported in this article was to determine relations between weight of roots per plot, percentage sucrose, and percentage apparent purity and levels of total nitrogen, potassium and sodium in the petioles as compared with levels of these same chemicals in the thin juice. Also the relations between levels of phosphorus in the petioles with weight of roots per plot, percentage sucrose and percentage apparent purity were studied. The petioles analyzed were collected at time of harvest and the thin juice was prepared from the roots harvested.

- 1/ The breeding and genetic phases of Project 25 are cooperative with the Agronomy and Chemistry Departments of the Colorado State University Agricultural Experiment Station, the Mathematics Department of C.S.U., and the Beet Sugar Development Foundation.
- 2/ Acknowledgments are due the Western Data Processing Center at the University of California at Los Angeles for use of the computing facilities for analysing data, Job Numbers 398 and 1081.
- 3/ The writers are indebted to R. Ralph Wood of the Great Western Sugar Company for obtaining thin-juice samples by an oxalate method standard with his company.
- 4/ Figures in parentheses refer to literature cited.

Literature Review

The literature pertaining to combining ability in sugarbeets is rather limited. This probably is due to the fact that until quite recently the number of inbred lines of sugarbeets available for testing has been and, comparatively speaking, still is rather limited.

Oldemeyer (4) used a commercial sugarbeet variety and the red marker beet as topcross testers to determine the general combining ability of inbred lines of sugarbeets and concluded that the red marker beet is satisfactory to test general combining ability for both yield and percentage sucrose. Peterson and Dickenson (8) using the red-marker beet to test for general combining ability found that the single crosses producing the most sugar per acre were those whose parents were high in general combining ability when tested by crossing with the red-marker beet and whose F_1 hybrids exhibited heterosis for percentage sucrose.

Oldemeyer and Rush (3) made a very interesting study using male-sterile testers. Seventeen self-fertile inbred lines and one open-pollinated variety of sugarbeets were crossed to five cytoplasmic male-sterile tester lines. The hybrids and their corresponding parents were grown in a field test. The results of this test showed that there are differences among the inbred lines for general combining ability and that specific combining ability is important, particularly in regard to yield. Heterosis and phenotypic dominance were found for both yield and sucrose percentage. Parental performance showed little association with the combining ability of their respective inbreds. This points out the necessity of making test crosses when evaluating inbreds. The variance attributable to the males and females is considered by them to be an index of that part of the over-all variation among the test crosses, due to the general combining ability, of the parents. The interaction variance (male X female) is considered an index of that part of the over-all variation, due to specific combining ability. To study the effect of specific combining ability, the means of the individual crosses were adjusted by adding to, or subtracting from them, the deviations of the means of all respective crosses of each parent from the test averages.

Helmerick et al. (2) employing varietal crosses made rather extensive studies pertaining to heterosis and combining ability. They concluded that rather substantial gains could be made by utilizing heterosis in the production of beet sugar. They also studied the environmental and genetic variances and identifiable proportion of genetic deviates and pointed out the value of this information in breeding hybrid populations of sugarbeets.

Powers et al. (9) conducted studies which showed that certain planting arrangements in isolation plots containing two parental sources resulted in approximately 68 percent of the progeny being the result of cross-fertilization between sources and that probably the remaining 32 percent of the progeny resulted from cross-fertilization between plants within sources. Other studies (10, 11, and 12) showed that certain inbreds produced hybrids that exhibited heterosis for percentage sucrose and percentage apparent purity. It is expected that heterosis for weight per root would be obtained. Such was found to be the case.

Chemical genetic studies (Powers et al. 12) revealed that the dominance phenomena for the chemical characters associated with percentage sucrose and percentage apparent purity are such as to result in both of these characters exhibiting heterosis in hybrids between certain selected inbred lines. This indicates that by employing those methods of breeding designed to utilize heterosis, hybrid populations can be bred that are superior in weight per root, percentage sucrose, and percentage apparent purity to those varieties now being grown for the production of beet sugar. Some such hybrid combinations involving inbred lines were obtained.

For methods of chemical analysis see Payne et al. (6 and 5) and for a review of the literature involving the heritability of the chemical characters see Powers et al. (10 and 11) and Finkner et al. (1).

Materials and Design of the Experiment

The materials used in the study are as follows: There is a total of 20 populations in the experiment. One is a commercial variety, 4 are three-way hybrids, each composed of 3 inbreds, and 15 are F_1 hybrids, each composed of 2 inbreds. The dates of harvest are September 14, October 3, and October 16. The characters studied are weight of roots per plot, percentage sucrose, percentage apparent purity, and levels of total nitrogen, potassium and sodium in the petioles and in the thin juice, and levels of phosphorus in the petioles. Weight of roots per plot are expressed as kilograms, sucrose and purity as percentages, the levels of the chemical characters are expressed as milligrams per 100 grams in the petioles, and the levels of the chemical characters are expressed as milligrams per 100 milliliters of thin juice equated to a refractive dry substance of 10 in the thin juice. The thin juice was prepared by The Great Western Sugar Company by an oxalate method standard with them. In this process the nitrate nitrogen is removed. Hence the total nitrogen for the thin juice does not include all the nitrogenous compounds found in the total nitrogen analysis of the petioles. However, as shown by Powers et al. (11), the association between total nitrogen in the thin juice and the press juice is extremely high, most of the variability of one being accounted for by the variability of the other.

The design of the experiment is a split plot with populations randomized within replications and dates of harvest randomized within blocks. Each block is composed of three dates of harvest and each date of harvest has two replications with 20 populations randomized within each replication. There are five such blocks. Hence, the design of the experiment is a modified randomized complete block.

Results

The F values calculated from the analyses of variance for all the characters are listed in table 1. For all characters, there are significant differences between means of populations. There are significant differences between means of dates of harvest for percentage sucrose and possibly for levels of sodium in the thin juice. The interactions having possible statistical significance are for the characters percentage sucrose, percentage apparent purity, and levels of sodium in the petioles. The interaction involving the levels of phosphorus in the petioles is fairly well established statistically. The data will be considered on the basis of the average of all dates of harvest as the amount of the variability accounted for by the interactions involving dates of harvest is small, comparatively. The interactions that are of greatest importance in this article involve populations, chemical constituents, and materials analyzed.

Table 1.—The F values calculated from the analyses of variance for weight per plot, percentage sucrose, percentage apparent purity, levels of total nitrogen, potassium, and sodium in the petioles and in the thin juice and levels of phosphorus in the petioles. ^{1/}

Variation due to:	Weight per plot	Percent- age sucrose	Percent- age apparent purity	Total nitrogen		Potassium		Sodium		Phos- phorus Petioles	Value of F at:		
				Petioles	Thin juice	Petioles	Thin juice	Petioles	Thin juice		5%	1%	1%
Populations ^{2/}	33.59	22.81	22.38	6.85	41.84	48.87	19.43	9.62	9.36	8.37	1.60	1.92	
Dates ^{3/}	—	16.24	—	—	—	—	1.59	1.99	7.80	1.80	4.46	8.65	
P X D ^{2/}	—	1.41	1.42	1.22	1.20	1.33	—	1.45	1.08	1.90	1.42	1.64	

^{1/} ——— signifies that the error mean square is the larger.

^{2/} An error mean square composed of the interactions B X P, R X P, B X R X P, B X P X D, R X P X D, and B X R X P X D with 513 degrees of freedom was used to calculate F values for populations and populations X dates.

^{3/} An error mean square composed of the interaction B X D with 8 degrees of freedom was used to calculate the F value for dates.

The means for weight per plot, percentage sucrose, and percentage apparent purity; for levels of total nitrogen, potassium, and sodium in the petioles and in the thin juice; and levels of phosphorus in the petioles are listed in table 2. Also, the least significant differences and the grand averages are listed at the bottom of this table. Powers et al. (13) have shown that very little of the environmental variability is included in the differences between the means of populations. Hence, the differences noted between means of populations are predominantly genetic. In this article, the data in table 2 have their greatest interest in the degrees of association between the level of a chemical in the petioles and the level of the same chemical in the thin juice, their corresponding interactions, and the association of the level of these chemicals with the important agronomic characters, weight of roots per plot, percentage sucrose, and percentage apparent purity. The associations are determined by studying the simple correlation coefficients.

Table 2.—Means for weight per plot, percentage sucrose, and percentage apparent purity for levels of total nitrogen, potassium, and sodium in the petioles and in the thin juice and levels of phosphorus in the petioles.

Population	Entry number	Weight per plot Kg	Sucrose %	Purity %	Total nitrogen		Potassium		Sodium		Phosphorus	
					Petioles	Thin juice	Petioles	Thin juice	Petioles	Thin juice	Petioles	Thin juice
					Mg/100gm	Mg/100ml	Mg/100gm	Mg/100ml	Mg/100gm	Mg/100ml	Mg/100gm	Mg/100ml
52-430 X 52-407 F ₁	1	6.595	14.9	93.9	1365.0	49.2	16.2	66.3	40.6	50.3	178.0	
52-305 CMS X (52-430 X 52-407) F ₁	2	5.678	14.9	92.6	1376.7	56.1	24.2	69.9	32.3	43.9	186.7	
52-305 CMS X 52-430 F ₁	3	4.560	15.8	93.7	1374.0	49.6	26.5	65.7	28.5	37.2	194.2	
52-305 CMS X 52-407 F ₁	4	5.542	14.7	91.0	1345.0	62.1	17.0	73.4	34.5	39.3	166.0	
52-430 X 52-307 F ₁	5	7.047	15.2	95.0	1470.8	40.9	18.0	53.9	35.9	45.2	201.6	
52-305 CMS X 52-307 F ₁	6	5.975	14.6	93.6	1489.8	52.3	27.8	62.2	32.2	41.8	196.2	
52-430 X 52-408 F ₁	7	7.358	15.5	94.7	1431.8	44.8	21.1	60.4	36.9	36.8	186.8	
52-430 X 54-520 F ₁	8	5.498	15.7	92.9	1488.7	57.6	13.8	60.0	35.3	36.5	195.1	
52-305 CMS X 54-520 F ₁	9	5.643	15.3	92.1	1383.5	65.6	17.9	65.2	31.3	37.8	176.8	
52-430 X 54-565 F ₁	10	4.802	16.3	95.6	1330.8	41.6	18.4	44.7	32.9	30.9	221.0	
52-305 CMS X 54-565 F ₁	11	5.050	16.1	94.9	1431.7	45.6	24.1	48.2	30.9	30.6	202.8	
52-305 CMS X 54-458 F ₁	12	5.257	14.8	91.8	1321.0	64.9	16.4	71.9	32.0	39.4	170.1	
52-430 X 54-346 F ₁	13	5.465	16.2	95.7	1278.2	37.4	14.2	41.9	32.3	38.0	195.2	
52-305 CMS X 54-346 F ₁	14	5.052	15.6	94.9	1315.3	42.0	20.7	53.1	32.7	35.9	182.3	
52-305 CMS X (52-430 X 54-346) F ₁	15	5.173	15.8	94.2	1316.2	44.5	20.5	53.6	30.4	37.3	182.3	
52-305 CMS X (52-430 X 54-520) F ₁	16	5.095	15.4	92.2	1442.6	65.2	22.4	67.2	30.8	36.3	194.2	
52-305 CMS X 34 F ₁	17	6.128	15.2	92.9	1485.7	61.3	24.7	57.9	35.4	42.1	172.1	
52-305 CMS X (54-458 X 34) F ₁	18	6.173	15.1	92.0	1404.5	60.1	21.0	62.1	33.7	36.8	177.9	
54-565 X 52-407 F ₁	19	5.625	14.8	92.5	1488.2	57.4	17.9	73.2	39.0	46.0	204.7	
A56-3	20	7.843	14.0	93.1	1531.2	54.4	16.4	60.7	35.9	55.7	206.5	
LSD at 5%		0.414	0.34	0.80	77.8	3.9	1.6	5.7	2.7	5.5	13.5	
LSD at 1%		0.545	0.45	1.06	102.6	5.1	2.1	7.6	3.5	7.2	17.8	
Average		5.778	15.3	93.5	1403.5	52.6	20.0	60.6	33.7	39.9	189.5	

Associations

The simple correlation coefficients are listed in table 3.

Weight per plot is positively associated with levels of total nitrogen and sodium in the petioles and with levels of sodium in the thin juice. The association of weight per plot with levels of potassium in the petioles is not statistically significant, only 4 percent of the variability being accounted for by covariation. The association between percentage sucrose and total nitrogen in the petioles is negative and 22 percent of the variation is covariation. Likewise, the association between percentage sucrose and level of sodium in the petioles is negative and here 18 percent of the variation is covariation. In no case is the association between percentage apparent purity and levels of total nitrogen, potassium, and sodium in the petioles statistically significant.

Table 3.--Correlation coefficients for weight of roots per plot, percentage sucrose, and percentage apparent purity with levels of total nitrogen, potassium, sodium and phosphorus. ^{1/}

Character and material analysed	Weight per plot	Percentage sucrose	Percentage apparent purity
Total nitrogen			
Petioles	0.54	-0.47	-0.21
Thin juice	-0.03	-0.54	-0.95
Potassium			
Petioles	-0.20	0.03	0.02
Thin juice	0.09	-0.70	-0.85
Sodium			
Petioles	0.66	-0.43	-0.03
Thin juice	0.70	-0.80	-0.07
Phosphorus			
Petioles	-0.00	0.28	0.56

^{1/} The approximate value of r at the 5% level is 0.273.

Weight per plot does not show any statistically significant association with levels of total nitrogen or potassium in the thin juice. However, levels of total nitrogen in the thin juice and percentage apparent purity are very closely associated and the association is negative. Also levels of potassium in the thin juice are rather closely associated with percentage apparent purity and again the association is negative. With this high a degree of association, it is not at all likely that the breeder can obtain genotypes having a high purity and a high level of total nitrogen in the thin juice. The same associations hold for percentage sucrose and levels of total nitrogen and potassium in the thin juice but the associations are not nearly so pronounced. Likewise, percentage sucrose is rather strongly associated with levels of sodium in the thin juice and the association is negative, 64 percent of the variability being covariation.

These results show that at time of harvest it is much more desirable to have the higher levels of total nitrogen, potassium, and sodium in the petioles rather than in the thin juice; as here they are positively associated with weight of roots per plot and are not closely associated negatively with either percentage sucrose or percentage apparent purity. Levels of phosphorus in the petioles show little, if any, association with weight per plot, but the associations with percentage sucrose and percentage apparent purity are statistically significant and positive. However, the closeness of the association is not marked; the greatest amount of the variability being covariation is 31 percent.

The interactions of weight per plot, percentage sucrose, and percentage apparent purity with total nitrogen in the petioles and in the thin juice are depicted by the means listed in table 4. These populations are selected from table 2 because they show that certain combinations of characters can be obtained. The comparisons between the means of the F_1 hybrid 52-305 CMS X 54-458 and the F_1 hybrid 52-430 X 52-408 show that an increase of total nitrogen in the petioles and a decrease of total nitrogen in the thin juice are accompanied by increases in weight of roots per plot, percentage sucrose, and percentage apparent purity. The comparisons involving the F_1 hybrid 52-430 X 52-408 with A56-3 show that further increases of total nitrogen in the petioles and in the thin juice are accompanied by a further increase in weight per plot and by decided decreases in percentage sucrose and in percentage apparent purity. These comparisons confirm the relations shown by the correlation coefficients; namely, that increases of total nitrogen in the petioles rather than in the thin juice can result in an increase in all 3 of the important agronomic characters--weight per plot, percentage sucrose, and percentage apparent purity. They further show that an increase of total nitrogen in the thin juice does not have an adverse relation with weight of roots per plot but it does have decidedly adverse relations with percentage sucrose and percentage apparent purity. Hence, weight of roots per plot, percentage sucrose, and percentage apparent purity in some populations are favorably associated with total nitrogen in the petioles but not with total nitrogen in the thin juice.

Hence, the breeder should be able to increase these three desirable agronomic characters by breeding genotypes having high levels of total nitrogen in the petioles at time of harvest. These results indicate that higher levels of total nitrogen in the petioles may be conducive to higher yields and are not conducive to lower percentage sucrose and lower percentage purity; whereas higher levels of total nitrogen in the thin juice are not conducive to higher yields but are conducive to lower percentage sucrose and lower percentage apparent purity. Then, it seems as though the plant breeder can improve both yield and quality by genetically controlling the location, at time of harvest, of the higher levels of total nitrogen; that is, breeding those genotypes having higher levels of this chemical in the petioles instead of the thin juice.

The means showing the interactions of weight per plot, percentage sucrose, and percentage apparent purity with levels of potassium in the petioles and in the thin juice are listed in table 5. The comparisons involving the two F_1 hybrids 52-305 CMS X 54-458 and 52-430 X 52-408 show that an increase in levels of potassium in the petioles and a decrease in the levels of the potassium in the thin juice are accompanied by material increases in weight per plot, percentage sucrose, and percentage apparent purity. The comparisons between populations 52-430 X 52-408 and A56-3 show that a decrease in the level of potassium in the petioles and no change in the level of potassium in the thin juice are accompanied by decreases in percentage sucrose and percentage apparent purity and a comparatively small increase in weight per plot. As for levels of total nitrogen, increased levels of potassium in the petioles are associated with increased percentage sucrose and percentage apparent purity, whereas increases in levels of potassium in the thin juice show the reverse associations. Again, if higher levels of potassium are essential to those metabolic processes conducive to higher yields, it is more desirable to have these higher levels in the petioles at time of harvest rather than in the thin juice.

Table 4.--Interactions of weight per plot, percentage sucrose, and percentage apparent purity with levels of total nitrogen in the petioles and in the thin juice.

Population	Weight	Sucrose	Purity	Total nitrogen	
				Petioles	Thin juice
	Kg	%	%	Mg/100gm	Mg/100ml
52-305 CMS					
X 54-458 F ₁	5.257	14.8	91.8	1321.0	64.9
52-430 X					
52-408 F ₁	7.358	15.5	94.7	1431.8	44.8
A56-3	7.843	14.0	93.1	1531.2	54.4
LSD at 5%	0.414	0.34	0.80	77.8	3.9
LSD at 1%	0.545	0.45	1.06	102.6	5.1

Table 5.--Interactions of weight per plot, percentage sucrose, and percentage apparent purity with levels of potassium in the petioles and in the thin juice.

Population	Weight	Sucrose	Purity	Potassium	
				Petioles	Thin juice
	Kg	%	%	Mg/100gm	Mg/100ml
52-305 CMS					
X 54-458 F ₁	5.257	14.8	91.8	16.4	71.9
52-430 X					
52-408 F ₁	7.358	15.5	94.7	21.1	60.4
A56-3	7.843	14.0	93.1	16.4	60.7
LSD at 5%	0.414	0.34	0.80	1.6	5.7
LSD at 1%	0.545	0.45	1.06	2.1	7.6

The means showing the interactions of weight per plot, percentage sucrose, and percentage apparent purity with levels of sodium in the petioles and in the thin juice are listed in table 6. Comparing the F₁ hybrids 52-305 CMS X 54-458 and 52-430 X 52-408 it can be seen that an increase in levels of sodium in the petioles and no material change in levels of sodium in the thin juice are accompanied by increases in weight of roots per plot, percentage sucrose, and percentage apparent purity. Comparing 52-430 X 52-408 and A56-3 no material change in levels of sodium in the petioles and an increase in levels of sodium in the thin juice are associated with decided decreases in percentage sucrose and percentage apparent purity and a moderate increase in weight of roots per plot. Again, if higher levels of sodium are conducive to favorable metabolic processes in the sugarbeet plant, it is preferable to have the higher levels in the petioles rather than having the higher levels in the thin juice at time of harvest.

Table 6.--Interactions of weight per plot, percentage sucrose, and percentage apparent purity with levels of sodium in the petioles and in the thin juice.

Population	Weight	Sucrose	Purity	Sodium	
				Petioles	Thin juice
	Kg	%	%	Mg/100gm	Mg/100ml
52-305 CMS X 54-458 F ₁	5.257	14.8	91.8	32.0	39.4
52-430 X 52-408 F ₁	7.358	15.5	94.7	36.9	36.8
A56-3	7.843	14.0	93.1	35.9	55.7
LSD at 5%	0.414	0.34	0.80	2.7	5.5
LSD at 1%	0.545	0.45	1.06	3.5	7.2

The means showing the interactions of weight per plot, percentage sucrose, and percentage apparent purity with levels of phosphorus in the petioles are listed in table 7. For all three populations listed in this table, the higher levels of phosphorus in the petioles are associated with increases in weight of roots per plot and there are no consistent relations involving percentage sucrose and percentage apparent purity. However, from the correlation coefficients listed in table 3 it can be seen that, on an average, the genetic variability shows the association between weight of roots per plot and levels of phosphorus in the petioles to be negligible; whereas those involving sucrose and purity are not marked but are statistically significant and favorable, being positive.

Table 7.--Interactions of weight per plot, percentage sucrose, and percentage apparent purity with levels of phosphorus in the petioles.

Population	Weight	Sucrose	Purity	Phosphorus Petioles
	Kg	%	%	Mg/100gm
52-305 CMS				
X 54-458 F ₁	5.257	14.8	91.8	170.1
52-430 X				
52-408 F ₁	7.358	15.5	94.7	186.8
A56-3	7.843	14.0	93.1	206.5
LSD at 5%	0.414	0.34	0.80	13.5
LSD at 1%	0.545	0.45	1.06	17.8

Discussion and Summary

(1) The associations between levels of total nitrogen in the thin juice, percentage sucrose, and percentage apparent purity are negative and for percentage apparent purity is extremely close. In fact, the association is so close ($r = -0.95$) as to practically preclude the possibility of genetically combining high total nitrogen in the thin juice with high percentage apparent purity. However, the association between high levels of total nitrogen in the petioles and high percentage apparent purity is much lower, only 4 percent of the variability being attributable to covariance. Moreover, the higher levels of total nitrogen in the petioles are positively associated with higher yields of roots (weight of root per plot). This indicates that high levels of total nitrogen in the petioles are conducive to greater weight of roots per plot. Percentage sucrose is adversely affected by higher levels of total nitrogen in the petioles but the adverse effects are not as marked as for higher levels of total nitrogen in the thin juice. In fact, only 22 percent of the variability is covariance, indicating that genetically higher levels of total nitrogen in the petioles can be combined with higher percentage sucrose. The data in table 4 for the F_1 hybrid 52-430 X 52-408, as pointed out in the discussion under results, show that these two chemical characters can be favorably recombined.

(2) Essentially the same findings hold for levels of potassium, sodium, and phosphorus. That is, it is much more desirable to have the higher levels of these chemicals in the petioles as contrasted with the thin juice.

(3) Further, it seems that the higher levels of total nitrogen, potassium, and sodium in the petioles are conducive, if not essential, to the production of higher yields. The higher levels of phosphorus in the petioles appear to be conducive to higher percentage sucrose and higher percentage apparent purity. The relation is stronger for percentage apparent purity than for percentage sucrose.

(4) Finally, there seems to be no reason why the metabolic requirements for higher yields of roots, higher percentage sucrose, and higher percentage apparent purity cannot be met by producing and growing genotypes which, at the time of harvest, tend to have the higher levels of total nitrogen, potassium, sodium, and phosphorus in the petioles rather than in the thin juice.

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Levels of Total Nitrogen, Potassium and Sodium in the Petioles and in the Thin Juice of Sugarbeets

In 1961 studies were conducted to determine levels of total nitrogen, potassium and sodium in the petioles as compared with levels of these same chemicals in the thin juice. The petioles are a structure of the tops of the sugarbeet and the thin juice is prepared from the roots of the same plant. The primary purpose of the study was to determine whether genotypes differ as to levels of these chemical constituents in the petioles and in the thin juice and, if so, whether some genotypes tend to have higher levels in the petioles and lower levels in the thin juice, whereas for other genotypes the reverse is true. In other words, is there an interaction of genotypes and material analysed (petioles or thin juice) as regards levels of total nitrogen, potassium and sodium? Such information is of great fundamental and practical importance to the beet sugar industry as these chemicals have been found to be associated with yield and quality.

Literature Review

Emmert (2, 3, 4) working with tomatoes, lettuce, and cucumbers developed rapid methods for estimating nitrate nitrogen, phosphate, and potassium in plants. He believed that inasmuch as the nutrients derived by a growing plant from the soil must enter in solution through the stem the concentration of a given nutrient in this mature conductive tissue should be directly proportional to the available supply of the nutrient in the soil. Hence, a measure of the concentration of nutrients in this conductive tissue may be a better measure of the ability of the soil to supply nutrients to growing plants than chemical tests of the soil itself. Also, he felt that an optimum content of nutrients in this kind of tissue exists for the various stages of growth of each kind of crop, regardless of the kind of soil in which the crop is growing. His researches supported these deductions and hence seemed to justify the practice of analyzing the mature conducting tissues of the plant to determine the ability of the soil to provide the nutrient requirements. Gardner and Robertson (5) analyzed petioles of sugarbeets and used the analyses in determining fertilizer needs as regards nitrate, phosphate and potassium.

Ulrich (15, 16, 17) has conducted extensive experiments with sugarbeets, studying yield and quality as regards fertilizer practices. He found a negative relation between levels of nitrate nitrogen in the petioles and percentage sucrose of the roots. He also established the optimum level of nitrate nitrogen in the petioles as regards percentage sucrose to be approximately 1000 ppm. He found that, once the critical nutrient level for an element has been established for a crop through many field experiments,

plant analysis has the following applications: (1) determination of the kind of nutrient that might be deficient in the field; (2) estimation of the time of application and the amount of fertilizer to apply; (3) aid in selecting the location of fertilizer experiments; and (4) aid in maintenance of the proper level of soil fertility. Also, some of the beet sugar companies have used the techniques he developed to determine fertilizer practices and established dates of harvest. Probably one of the more important contributions of the researches by Ulrich is the stimulation of rather extensive researches on the effect of fertilizer practices on the yield, quality and processing of sugarbeets.

Rorabaugh and Norman (11) found the order in which some of the common beet-sirup impurities adversely affect crystallization of sugar, during factory processing, to be as follows: (1) carbonate and chloride salts, (2) amino acids, (3) betaine and non-nitrogenous organic acids, and (4) sulfate salts. They found the carbonates and chlorides to be strongly melassigenic and to be present in relatively large concentrations in the beet sirups. Hence, the carbonates and chlorides accounted for a large fraction of the total sugar lost in molasses. They conclude that the most fertile ground for improvement of the crystallization characteristic lies in the elimination of carbonate and chloride salts with lowering of pyrolidonecarboxylic acid and that glutamic acid is the second most likely point of attack. They further point out that the case against pyrolidonecarboxylic acid and glutamic acid is a two-edged one, since not only are they major contributors to sugar loss in molasses, but also decomposition of glutamine, the amide from which they originate, causes processing difficulties through lowering of buffering capacity of juice and lowering alkalinity. The rather extensive studies of Carruthers and Oldfield (1) in general agree with those of Rorabaugh and Norman (11). In addition, Carruthers and Oldfield present methods of assessing quality that appear to have considerable merit and hence extensive application.

Haddock, Linton and Hurst (6) found that nitrogen fertilization and nitrogen plant composition are closely associated with sucrose storage in beet roots and sugar recoveries from extract juice. Also, they found that the soluble nitrogen constituents of the sugar beet roots are highly associated with, if not responsible for, variations in purity and sucrose percentage as well as dry matter percentage. From their studies the particular components which appear to be most highly associated with changes in quality are the glutamine and ammonia fractions. They believe the glutamine nitrogen to be of greatest significance in quality variation, because of its high association with quality factors and because the concentration of this form of nitrogen is ten times that of ammonia nitrogen.

Rounds et al. (12) found that the nitrogen levels caused greater variations in the amounts of nonsugars present in the beet roots than did the varieties tested. Significant interactions of varieties X nitrogen fertility levels were found for sodium content. The data presented indicate that both varieties and nitrogen fertility levels can appreciably influence the amount of nonsugars in beets. The association of total nitrogen and nitrogen compounds with reduced purity and extraction in the roots was pronounced. Ryser et al. (13) in a comparison of harvest dates found that the sugars from the late harvest were higher than from the early harvest, while the purities were lower. The unexpected decrease in purity was not accounted for by an increase in the level of amino nitrogen. Levels of nitrate-nitrogen in the petioles, amino N in the roots, and Na content in the roots were greatly influenced by high nitrogen fertilization, but varietal differences were just as striking. In Na content, a four or fivefold difference between low Na types and high Na types was not uncommon.

Owen et al. (7) found that highest purity was not always associated with highest percentage sucrose. They attributed their results to be due to an interaction between genotypes (as represented by hybrids) and locations. Powers et al. (8) found that some genotypes might have a high nitrate nitrogen content in the petioles and low total nitrogen in the thin juice as compared with other genotypes. The same was found to hold true for potassium. Some populations were found to be high in level of potassium in the petioles and low in levels of potassium in the thin juice as compared with other populations.

Materials and Design of the Experiment

The materials used in the study are as follows. There is a total of 20 populations in the experiment. One is a commercial variety; 4 are threeway hybrids, each composed of 3 inbreds; and 15 are F_1 hybrids, each composed of 2 inbreds. The dates of harvest are September 14, October 3, and October 16. The characters studied are levels of total nitrogen, potassium and sodium in the petioles and in the thin juice. In the petioles the characters are expressed as milligrams per 100 grams and in the thin juice as milligrams per 100 milliliters of thin juice equated to a refractive dry substance of 10. The thin juice was prepared by the Great Western Sugar Company by an oxalate method standard with them. In the process the nitrate nitrogens are removed. Hence the total nitrogen for the thin juice does not include all the nitrogenous compounds found in the total nitrogen analysis of the petioles.

The design of the experiment is a split plot with populations randomized within replications and dates of harvest randomized within blocks. Each block is composed of 3 dates of harvest and each date of harvest has 2 replications with 20 populations randomized within each replication. There are 5 such blocks. Hence the design of the experiment is a modified randomized complete block.

Results

The F values calculated from an analysis of variance are listed in table 1. A study of this table reveals that there are significant differences between populations as regards all chemical characters for both the levels in the petioles and in the thin juice. This is not true for dates of harvest (with the possible exception of sodium in the thin juice) as the differences noted between dates of harvest can readily be explained by chance. This is also true of the first order interaction of populations X dates of harvest. It may be concluded that the changes in levels of total nitrogen, potassium and sodium when harvested September 14, October 3, and October 16 have little if any practical significance. Further research is necessary to determine whether the changes in levels of sodium for the different dates of harvest are other than chance deviations, as for the thin juice they were significant at the 5% level, but just barely so. For that reason the different dates of harvest will not be considered individually in this article.

Table 1.--The F values calculated from the analyses of variance for levels of total nitrogen, potassium, and sodium in the petioles and in the thin juice.^{1/}

Variation due to:	Total nitrogen		Potassium		Sodium		Value of F at;	
	Petioles	Thin juice	Petioles	Thin juice	Petioles	Thin juice	5%	1%
Populations	6.85	41.84	48.87	19.43	9.62	9.36	1.60	1.92
Dates	-----	-----	-----	1.59	1.99	7.80	4.46	8.65
P X D	1.22	1.20	1.33	-----	1.45	1.08	1.42	1.64

^{1/} ----- signifies that the error mean square is the larger.

The means and least significant differences for levels of total nitrogen, potassium, and sodium in the petioles and in the thin juice are listed in table 2. As has been shown by Powers et al. (10) very little environmental variability is included in the differences between means of populations, the differences noted are predominantly genetic. In this article the data in table 2 have their greatest interest in the degrees of association between levels of a chemical in the petioles and the level of the same chemical in the thin juice; and the interactions involving levels of the chemicals in the petioles as compared with levels of the chemicals in the thin juice. The correlation coefficients will be considered first.

Table 2.—Means and the least significant differences for levels of total nitrogen, potassium, sodium, and sodium in the petioles and in the thin juice.

Population, LSD and average	Entry number	Total nitrogen		Potassium		Sodium	
		Petioles	Thin juice	Petioles	Thin juice	Petioles	Thin juice
		Mg/100gm	Mg/100ml	Mg/100gm	Mg/100ml	Mg/100gm	Mg/100ml
52-430 X 52-407 F ₁	1	1365.0	49.2	16.2	66.3	40.6	50.3
52-305 CMS X (52-430 X 52-407) F ₁	2	1376.7	56.1	24.2	69.9	32.3	43.9
52-305 CMS X 52-430 F ₁	3	1374.0	49.6	26.5	65.7	28.5	37.2
52-305 CMS X 52-407 F ₁	4	1345.0	62.1	17.0	73.4	34.5	39.3
52-430 X 52-307 F ₁	5	1470.8	40.9	18.0	53.9	35.9	45.2
52-305 CMS X 52-307 F ₁	6	1489.8	52.3	27.8	62.2	32.2	41.8
52-430 X 52-408 F ₁	7	1431.8	44.8	21.1	60.4	36.9	36.8
52-430 X 54-520 F ₁	8	1488.7	57.6	13.8	60.0	35.3	36.5
52-305 CMS X 54-520 F ₁	9	1383.5	65.6	17.9	65.2	31.3	37.8
52-430 X 54-565 F ₁	10	1330.8	41.6	18.4	44.7	32.9	30.9
52-305 CMS X 54-565 F ₁	11	1431.7	45.6	24.1	48.2	30.9	30.6
52-305 CMS X 54-458 F ₁	12	1321.0	64.9	16.4	71.9	32.0	39.4
52-430 X 54-346 F ₁	13	1278.2	37.4	14.2	41.9	32.3	38.0
52-305 CMS X 54-346 F ₁	14	1315.3	42.0	20.7	53.1	32.7	35.9
52-305 CMS X (52-430 X 54-346) F ₁	15	1316.2	44.5	20.5	53.6	30.4	37.3
52-305 CMS X (52-430 X 54-520) F ₁	16	1442.6	65.2	22.4	67.2	30.8	36.3
52-305 CMS X 34 F ₁	17	1485.7	61.3	24.7	57.9	35.4	42.1
52-305 CMS X (54-458 X 34) F ₁	18	1404.5	60.1	21.0	62.1	33.7	36.8
54-565 X 52-407 F ₁	19	1488.2	57.4	17.9	73.2	39.0	46.0
A56-3	20	1531.2	54.4	16.4	60.7	35.9	55.7
LSD at 5%		77.8	3.9	1.6	5.7	2.7	5.5
LSD at 1%		102.6	5.1	2.1	7.6	3.5	7.2
Average		1403.5	52.6	20.0	60.6	33.7	39.9

Associations

From table 3 it can be seen that the correlation between total nitrogen in the petioles and in the thin juice is 0.29, between potassium in the petioles and in the thin juice is 0.06, and finally between sodium in the petioles and in the thin juice is 0.60. Hence the greatest percent of the variability accounted for by the correlation of a chemical in the petioles and in the thin juice is 36 percent and is for sodium.

The strongest association (-0.44) between chemicals in the petioles involves potassium and sodium and here only 19 percent of the genetic variation of one is accounted for by the genetic variation of the other. The greatest association between chemicals in the thin juice is 0.77 and involves total nitrogen and potassium. Here 59 percent of the total variation is covariation. The next strongest association for the thin juice is 0.40 and is between potassium and sodium.

Further, from the correlation coefficients listed in table 3 it can be determined that in no case is a chemical character in the petioles closely associated with another chemical character in the thin juice. These results show that by proper breeding procedures it should be possible to recombine desirable levels of these chemical characters in the petioles with desirable levels of the same characters in the thin juice.

Table 3.--Correlation coefficients for levels of total nitrogen, potassium and sodium in the petioles and in the thin juice. ^{1/}

Character and material analysed	Total nitrogen	Potassium		Sodium	
	Thin juice	Petioles	Thin juice	Petioles	Thin juice
Total nitrogen					
Petioles	0.29	0.20	0.22	0.38	0.43
Thin juice		0.03	0.77	-0.01	0.15
Potassium					
Petioles			0.06	-0.44	-0.21
Thin juice				0.21	0.40
Sodium					
Petioles					0.60
Thin juice					

^{1/} The approximate value of r at the 5% level is 0.273.

Interactions

The means showing the interactions are taken from table 2.

Means for levels of total nitrogen showing interactions of populations X materials analysed are listed in table 4. The F_1 hybrid 52-430 X 54-346 has a low level of total nitrogen in both the petioles and in the thin juice. The F_1 hybrid 52-305 CMS X 54-458 has a low level of total nitrogen in the petioles and a high level of total nitrogen in the thin juice. The F_1 hybrid (52-430 X 52-307) shows the reverse in that it has a high level of nitrogen in the petioles and a low level of nitrogen in the thin juice. The commercial variety A56-3 has the highest level of total nitrogen in the petioles and has an intermediate level of total nitrogen in the thin juice.

Table 4.—Means for levels of total nitrogen showing interactions of populations X materials analyzed.

Population	Total nitrogen	
	Petioles	Thin juice
	Mg/100gm	Mg/100ml
52-430 X 54-346 F_1	1278.2	37.4
52-305 CMS X 54-458 F_1	1321.0	64.9
52-430 X 52-307 F_1	1470.8	40.9
A56-3	1531.2	54.4
ISD at 5%	77.8	3.9
ISD at 1%	102.6	5.1

The comparisons for the F_1 hybrids 52-430 X 54-346 and the F_1 hybrid 52-305 CMS X 54-458 are not significant for total nitrogen in the petioles but are significant for total nitrogen in the thin juice. The comparisons for the F_1 hybrids 52-430 X 54-346 and 52-430 X 52-307 are statistically significant for the petioles and not for the thin juice. The comparisons for the F_1 hybrids 52-305 CMS X 54-458 and 52-430 X 52-307 are significant for both the petioles and the thin juice. The same is true for the comparison involving 52-305 CMS X 54-458 and A56-3. The comparison between the F_1 hybrid 52-430 X 52-307 and A56-3 are not significant for the petioles but are statistically significant for the thin juice.

These results definitely show that some populations at time of harvest have higher levels of total nitrogen in the petioles as compared to other varieties and lower levels of total nitrogen in the thin juice. The reverse is also true; some populations have high levels of total nitrogen in the thin juice and low levels of total nitrogen in the petioles as compared with other populations. These results definitely show that for total nitrogen there is an interaction between genotypes and material analyzed (petioles and thin juice). Hence by proper breeding procedures different combinations of levels of total nitrogen in the petioles and in the thin juice are attainable.

Means for levels of potassium showing interactions of populations X material analyzed are listed in table 5. The F_1 hybrid 52-430 X 54-346 has low potassium in both the petioles and in the thin juice, whereas 52-305 CMS X 54-458 is low in potassium in the petioles and high in potassium in the thin juice. The F_1 hybrid 52-305 CMS X 54-565 is high in potassium in the petioles and low in potassium in the thin juice. The variety A56-3 is low in potassium in the petioles and moderately high in potassium in the thin juice. Again there is an interaction between genotypes and levels of potassium in the petioles as compared with levels of potassium in the thin juice. It is apparent that genotypes can be obtained having different levels of potassium in the petioles and in the thin juice. That is, populations can be bred that have desirable levels of potassium in the petioles and desirable levels of potassium in the thin juice.

Table 5.--Means for levels of potassium showing interactions of populations X material analyzed.

Population	Potassium	
	Petioles	Thin juice
	Mg/100gm	Mg/100ml
52-430 X 54-346 F_1	14.2	41.9
52-305 CMS X 54-458 F_1	16.4	71.9
52-305 CMS X 54-565 F_1	24.1	48.2
A56-3	16.4	60.7
LSD at 5%	1.6	5.7
LSD at 1%	2.1	7.6

Means for levels of sodium showing interactions of populations X material analyzed are listed in table 6. The F₁ hybrid 52-305 CMS X 54-565 is low in levels of sodium in both the petioles and thin juice. The F₁ hybrid 52-305 CMS X 52-307 possesses a low level of sodium in the petioles and a high level of sodium in the thin juice. The F₁ hybrid 52-430 X 52-408 has the highest level of sodium in the petioles and a moderately low level of sodium in the thin juice. A56-3 has a high level of sodium in both the petioles and in the thin juice. In fact, it is significantly higher in level of sodium in the thin juice than any other population listed in table 6. Also for sodium, as was the case for total nitrogen and potassium, there is an interaction between genotypes and levels of sodium in the petioles as compared with levels of sodium in the thin juice. It follows that different combinations of levels of sodium in the petioles and in the thin juice can be obtained by proper breeding procedures.

Table 6.--Means for levels of sodium showing interactions of populations X materials analyzed.

Population	Sodium	
	Petioles	Thin juice
	Mg/100gm	Mg/100ml
52-305 CMS X 54-565 F ₁	30.9	30.6
52-305 CMS X 52-307 F ₁	32.2	41.8
52-430 X 52-408 F ₁	36.9	36.8
A56-3	35.9	55.7
LSD at 5%	2.7	5.5
LSD at 1%	3.5	7.2

Discussion

The interactions involving genotypes X material analyzed (petioles and thin juice) have shown that at time of harvest levels of the three chemicals vary in the petioles and thin juice according to populations. When interpreting these findings it is well to have in mind that the petioles are a part of the tops of the sugarbeet and the thin juice is prepared from the roots. Hence, it appears that at time of harvest some genotypes have the higher levels of these chemicals in the tops of the plant, whereas for other genotypes the higher levels are found in the roots as represented by analysis of the thin juice. These findings are of extreme importance to the beet sugar industry in that this shows populations can be bred that will have the higher levels of these three chemical characters in the tops of the plant rather than in the roots. These three chemicals at higher levels have a decided adverse effect on percentage sucrose and percentage apparent purity (see Powers and Payne, 9).

Hence, it becomes of importance to know whether the genotypes tending to have the higher levels of the three chemical characters in the petioles rather than in the thin juice, at time of harvest, have yielding ability. The results from the studies involving these three chemical characters and weight per root, percentage sucrose and percentage apparent purity are presented in another article (see Powers and Payne, 9).

Summary

(1) Populations of sugarbeets were found to differ in the relative levels of total nitrogen, potassium, and sodium in the petioles as compared with levels of these same chemicals in the thin juice. It is well to keep in mind that the petioles are part of the tops of the sugarbeet plant, whereas the thin juice is prepared from the roots.

(2) The interactions involving genotypes X materials analyzed (petioles or thin juice) have shown that, at time of harvest, higher levels of the three chemicals occur in either the petioles or the thin juice, or in both. Conversely, at time of harvest, some genotypes have higher levels of these three chemical characters in the petioles associated with lower levels in the thin juice.

(3) This latter finding is of extreme importance to the beet sugar industry, because it shows that populations can be bred that will have the higher levels of these chemicals in the tops (petioles) of the sugarbeet rather than in the roots (thin juice). The higher levels of these three chemicals in the thin juice have a decidedly adverse effect on percentage sucrose and on percentage apparent purity (see Powers and Payne, 9).

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The Partitioning Method of Genetic Analysis Applied to a Study of Weight Per Root and Percentage Sucrose in Sugarbeets (*Beta vulgaris* L.)

The partitioning method of genetic analysis (Powers 7, 9) is applied to a study of weight per root and percentage sucrose in sugarbeets (*Beta vulgaris* L.). The components of variance method of genetically studying populations, developed independently by Fisher (2) and Wright (14), and the partitioning method of genetic analysis are predicated on much the same basic theory. The two methods differ in that the former emphasizes a study of the variances and covariances, whereas the latter places more emphases on the frequency distributions. As pointed out by Falconer (1), Fisher, Wright, and many other statistical geneticists have extended the components of variance method of genetic analysis until today a substantial body of theory exists that is accepted as valid by most. The books by Lush (4), Mather (5), Lerner (3), and Falconer (1) have done much to clarify and promote use of these theories in both the theoretical and applied fields of genetics.

The purposes of this article are:

- (1) To illustrate and present in some detail the methods and procedures employed in analyzing the data.
- (2) To evaluate this method of analyzing the data by showing its relation to heritability ratios used in the components of variance method of studying quantitative characters.

Methods

The partitioning method of genetic analysis, as employed in this study, partitions the frequency distributions of segregating populations on the basis of populations comparatively free from genetic variation; namely, an inbred population and an F_1 hybrid population. This procedure provides an estimate of the identifiable numbers of genetic deviates in the lower and upper classes of the frequency distributions of the segregating populations. Also, the components of variance (total, environmental, and genetic) are estimated by using an inbred and an F_1 hybrid to estimate the environmental variation. The genetic variance is estimated by subtracting the estimate of the environmental variance from the total. From these components of variance, heritability ratios are calculated. Then, in turn, correlation is employed to determine the degree of association between the identifiable numbers of genetic deviates in upper and lower classes of the frequency distributions of segregating populations and their corresponding heritability ratios. Similar procedures are applied to the bivariate frequency distributions.

Previous partitioning of the obtained frequency distributions to estimate the identifiable numbers of genetic deviates in the lower and upper classes of the frequency distributions has been based on the assumption that the environmental variation results in frequency distributions normal in type (see Powers 8 and Powers et al. 10, 11, 12). In this study the frequency distributions are partitioned by methods not requiring any assumptions as to the type of the environmental frequency distribution (normal or otherwise). To accomplish this, the frequency distributions must be free from differences due to replications and differences due to populations. In other words, the frequency distributions must be adjusted so that there are no differences between replication means and adjusted so that there are no differences between means of populations. For replications this was done by taking the difference between the mean of any given culture (plot) and that of its respective population and adding or subtracting, as the case may require, this difference from the value of each plant in that culture. Then, to remove population differences, these values for each plant within a population were readjusted on the basis of the difference between the mean of a given population and the mean of all populations. The formula used in making the adjustments is: Adjusted observations = $x_{ijk} - (x_{ij.} - x_{i..}) - (x_{i..} - x_{...})$. In this formula x_{ijk} denotes the k th observation in the i th population and j th replication; $x_{ij.}$ the mean of the observations in population i , and replication j ; $x_{i..}$ the mean of the observations in population i ; and $x_{...}$ the grand mean of all populations.

For the partitioning of the segregating population frequency distributions to be valid, the magnitude of the within-plot variances should not be associated with the magnitude of the means, when non-segregating populations are used to estimate the frequency distributions attributable to environmental variation. If there is an association between the magnitude of the means and their corresponding variances, then the range of the frequency distribution attributable to environmental variation will be associated with the magnitude of the means also. Consequently, in such an event, the inbred and F_1 hybrid frequency distributions may not furnish valid estimates of the environmental frequency distributions of the segregating populations. Such would be expected, if the inbred mean and F_1 hybrid means are materially different from those of the segregating populations. Theoretically this difficulty is overcome by transforming the data to logarithms. Hence, such a transformation is employed. The adjustments described above and the transformation to logarithms are readily accomplished by the use of modern digital computers.

Materials and Experimental Design

The materials consist of inbreds, varieties, and hybrids. There are 19 different populations included in the studies.

CMS is a population of sugarbeets derived from cytoplasmic male-sterile plants of S.L. 211-H3 exposed to pollen from 20 different populations. By using 20 different pollen parents it was hoped a population having a broad genetic base would be obtained.

The individual plant 4W-34 is a selection from A54-1. This individual was increased by asexual reproduction to produce population 4W-34. Population 4W-34 S₂ is 4W-34 inbred by self-pollination for two generations. Population 4W-34AR was derived from seven roots selected from the progeny of 4W-34 grown in polycross test trials. This progeny in turn was produced from seed of 4W-34 grown in a polycross isolation plot with 31 other individual plant selections from A54-1. These 32 roots from A54-1 were selected for high weight per root and high percentage sucrose.

A54-1 is a commercial variety which was grown for several years in the Great Plains Region east of the Rocky Mountains. A56-3 is a seed increase of A54-1 made in Oregon by the Great Western Sugar Company. Populations 52-430, 54-520, 52-307, 52-305, and 34 are inbreds produced by self-pollination. Population A58-5 is a stock beet and A58-22 is SP 5832-0 which possesses considerable resistance to the organisms causing Cercospora leaf spot and Aphanamycetes root rot.

To produce the hybrids with CMS having 4W-34, A54-1, 4W-34 S₂, and 4W-34AR as pollen parents, 40 roots of CMS were quartered and one quarter was planted in each of four different isolation plots to produce the four topcross populations. The procedure was the same for the four topcross hybrids having 34, A54-1, A58-5, and A58-22 as pollen parents.

Of the CMS population 34 percent (27 plants among 80) of the progeny were cytoplasmic male-sterile plants. The pollen producers among the 40 CMS plants, used to produce each of the two groups of hybrids, were pulled and discarded before pollen was shed. This assured that the seed harvested from the cytoplasmic male-sterile plants resulted from cross fertilization.

The design of the experiment was a modified randomized complete block. There were two groups of populations, each composed of 12 entries. The populations were randomized within groups and replications, and the groups were randomized within replications. Hence, for each of the two groups of populations, taken individually, the design of the experiment was a randomized complete block. There are 30 replications. Since A56-3 is a seed increase of A54-1, these two populations represent duplicate entries within each replication and, hence, can be used to estimate the environmental variability due to differences between entries. Other entries were common to both groups, and hence, there were only 19 genetically different populations in the two groups.

Results

First, under results, the desirability and effects of transforming the original data to logarithms will be considered.

Transformation to Logarithms

The methods of analyses employed assume that there is no material relation between the magnitude of the variances and the magnitude of the means, as regards the environmental variability. The F_1 hybrid 52-430 X 52-307 is used to estimate the frequency distribution attributable to environmental variation for group 1. The frequency distribution of inbred 34 is used for the same purpose for group 2. For weight per root the total within plot variance for this F_1 hybrid calculated from the non-transformed data is 0.245688 and the corresponding mean is 1.21 ± 0.025 kilograms (see table 1). In group 2 the inbred 34 has a within-plot variance of 0.070413 and a mean of 0.69 ± 0.017 . Since the variabilities of this F_1 and inbred 34 are almost, if not entirely, attributable to environmental differences, these figures indicate a positive relation between the magnitude of the means and the magnitude of their corresponding variances before transformation of the data to logarithms. This was found to hold for other data on weights per root of the sugarbeet (see Powers et al. 12). To correct such a relation transformation of the original data to logarithms is commonly used.

Table 1.—Means and their standard errors, and total within-plot variances for weight per root in kilograms, data not transformed.

Population	Group 1		Group 2	
	Mean and standard error	Total within-plot variance $\frac{2}{\text{ }}$	Mean and standard error	Total within-plot variance $\frac{2}{\text{ }}$
Kg				
CMS X 4W-34, 1	1.17±0.030	0.385363	CMS X 34, 13	1.32±0.027 0.381195
CMS X A54-1, 2	1.19±0.028	0.388821	34, 14 $\frac{1}{\text{ }}$	0.69±0.017 0.070413
A54-1, 3	1.12±0.031	0.370423	CMS X A54-1, 15	1.23±0.034 0.395906
CMS X 4W-34 S ₂ , 4	1.09±0.026	0.282390	A54-1, 16	1.18±0.026 0.361635
4W-34 S ₂ , 5	0.92±0.026	0.281420	CMS X A58-5, 17	1.67±0.049 0.758110
CMS X 4W-34AR, 6	1.14±0.025	0.310506	A58-5, 18	1.75±0.062 0.683360
4W-34AR, 7	0.98±0.021	0.288190	CMS X A58-22, 19	1.24±0.031 0.368810
52-430 X 54-520 F ₁ , 8	1.08±0.020	0.275297	A58-22, 20	1.10±0.027 0.317241
52-430 X 52-307 F ₁ , 9 $\frac{1}{\text{ }}$	1.21±0.025	0.245688	52-430 X 54-520 F ₁ , 21	1.11±0.029 0.257153
54-520 X 52-305 F ₁ , 10	1.09±0.032	0.365298	54-520 X 52-305 F ₁ , 22	1.09±0.021 0.345386
A56-3, 11	1.09±0.028	0.328601	A56-3, 23	1.15±0.028 0.322516
54-520, 12	0.83±0.019	0.159033	54-520, 24	0.89±0.025 0.209671

$\frac{1}{\text{ }}$ Used to estimate the frequency distribution due to environmental variation.

$\frac{2}{\text{ }}$ The degrees of freedom for the total within-plot variances are 420.

Previous investigations (see Powers et al. 12) have shown no consistent relation between the means and within-plot variances for percentage sucrose. However, any tendency noted has been for those nonsegregating populations having the higher percentages sucrose to possess somewhat lower variances. Also, the means and variances for populations (52-430 X 52-307) F_1 and 34 show the same tendency (see table 2). This may be due to the existence of a ceiling for the upper limits of percentage sucrose.

In this study, both weight per root and percentage sucrose were transformed to logarithms. On the logarithmic scale the variance and the mean of the F_1 hybrid for weight per root are 0.04510436 and 0.038808 and for inbred 34 are 0.04084310 and -0.201723 (see table 3). The degrees of freedom for the two within-plot variances are 420. The F value calculated by dividing the F_1 variance by the variance of 34 is 1.10, and the corresponding value of P is greater than 0.05. It is apparent that the differences between the variances can be readily accounted for by chance fluctuations. On the other hand, the difference between the two means of the logarithms is highly statistically significant. The transformation to logarithms of the weights per root taken in kilograms has effectively removed the relation between the means and variances.

Table 2.—Means and their standard errors, and total within-plot variances for percentage sucrose, data not transformed.

Group 1			Group 2		
Population	Mean and standard error	Total within-plot variance $\frac{2}{\text{ }}$	Population	Mean and standard error	Total within-plot variance $\frac{2}{\text{ }}$
$\%$					
CMS X 4W-34, 1	16.7±0.19	1.915976	CMS X 34, 13	16.3±0.18	1.536331
CMS X A54-1, 2	16.5±0.16	1.965964	34, 14 $\frac{1}{\text{ }}$	16.4±0.21	1.795271
A54-1, 3	16.9±0.18	2.097929	CMS X A54-1, 15	16.0±0.17	2.435434
CMS X 4W-34 S ₂ , 4	17.2±0.13	1.609357	A54-1, 16	16.6±0.17	2.313297
4W-34 S ₂ , 5	17.0±0.16	1.612046	CMS X A58-5, 17	12.6±0.18	1.919944
CMS X 4W-34AR, 6	16.9±0.18	1.909500	A58-5, 18	9.1±0.18	2.815033
4W-34AR, 7	17.4±0.15	1.703176	CMS X A58-22, 19	15.7±0.18	2.347427
52-430 X 54-520 F ₁ , 8	17.1±0.14	1.482122	A58-22, 20	15.5±0.20	2.614335
52-430 X 52-307 F ₁ , 9 $\frac{1}{\text{ }}$	17.8±0.14	1.397220	52-430 X 54-520 F ₁ , 21	16.8±0.20	1.313386
54-520 X 52-305 F ₁ , 10	16.9±0.16	1.268957	54-520 X 52-305 F ₁ , 22	16.7±0.15	1.458935
A56-3, 11	16.9±0.19	2.061303	A56-3, 23	16.8±0.13	1.864405
54-520, 12	16.2±0.16	0.892398	54-520, 24	15.9±0.15	1.164662

$\frac{1}{\text{ }}$ Used to estimate the frequency distribution due to environmental variation.

$\frac{2}{\text{ }}$ The degrees of freedom for the total within-plot variances are 420.

Table 3.--Population frequency distributions adjusted to eliminate differences between replications with populations and differences between populations within groups, weight per root, data transformed to logarithms.

Group and population	Class																							Mean and standard error	Total variance	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23			
Group 1																										
CMS X 4W-34, 1	7	2	1	5	6	14	12	22	20	29	32	36	43	53	39	46	23	27	19	5	7	2		0.000541±0.013497	0.06743394	
CMS X A54-1, 2	1	5	3	8	10	11	9	14	24	31	33	42	44	45	45	33	36	26	18	6	6			0.009880±0.010993	0.06411969	
A54-1, 3	3	7	4	4	10	16	8	13	23	26	38	38	40	46	40	45	35	21	11	14	6	2		-0.023081±0.013235	0.07027052	
CMS X 4W-34 S ₂ , 4	8	5	5	5	2	12	11	18	18	26	24	37	51	48	55	37	48	19	12	7	2			-0.027082±0.011393	0.06558278	
4W-34 S ₂ , 5	3	1	8	8	15	10	17	26	13	18	33	39	35	44	52	31	28	22	24	14	5	4		-0.116082±0.013343	0.07671928	
CMS X 4W-34AR, 6	3	2	4	7	6	8	15	18	15	24	37	48	36	53	49	48	29	28	14	5	1			0.000359±0.010262	0.05902877	
4W-34AR, 7	4	5	5	6	8	10	13	22	21	22	29	41	42	50	39	41	27	30	20	8	4	3		-0.078184±0.010421	0.07051341	
52-430 X 54-520 F ₁ , 8	3	2	0	6	12	8	14	20	20	28	22	44	56	40	59	40	31	24	12	8	1			-0.024964±0.008868	0.05739611	
52-430 X 52-307 F ₁ , 9 1/2	5	3	0	2	4	10	7	15	14	16	46	61	53	57	59	45	32	12	9					0.038808±0.009620	0.04510436	
54-520 X 52-305 F ₁ , 10	6	6	3	13	8	7	12	17	27	25	27	26	41	50	37	44	41	26	14	11	9			-0.042082±0.013357	0.08069469	
A56-3, 11	5	1	8	4	9	6	18	15	28	25	30	35	43	50	42	38	36	24	20	5	8			-0.031330±0.013528	0.06837081	
54-520, 12	6	1	6	2	10	8	7	24	20	22	31	33	59	48	55	43	34	27	6	6	1	1		-0.138799±0.010292	0.05805029	
Group 2																										
CMS X 34, 13	5	0	1	1	5	6	7	16	14	26	27	47	41	58	51	44	46	28	13	11	0	2	1		0.067151±0.009173	0.05314274
34, 14 1/2		2	3	0	4	6	10	17	13		16	19	41	55	64	68	63	32	26	7	3	1			-0.201723±0.012724	0.04084310
CMS X A54-1, 15	4	2	2	3	5	12	16	13	24	23	23	28	36	42	53	41	43	37	20	10	10	3		0.020913±0.014323	0.07005840	
A54-1, 16	4	2	6	6	7	4	10	14	11	27	29	33	41	49	42	48	47	30	16	14	5	4	1		0.005712±0.011895	0.06877882
CMS X A58-5, 17	2	3	1	4	3	12	9	22	17	24	35	32	39	36	49	51	30	35	17	16	10	3		0.153730±0.015737	0.06517320	
A58-5, 18	4	4	0	1	4	7	9	8	19	27	32	35	50	52	58	41	35	29	20	11	4			0.184200±0.017684	0.05431556	
CMS X A58-22, 19	2	1	4	5	6	10	9	14	16	26	22	30	49	50	52	42	42	34	15	14	7			0.033208±0.011374	0.05991783	
A58-22, 20	5	1	5	4	2	6	18	16	12	22	27	50	39	37	40	45	37	42	23	9	6	2	2		-0.025652±0.013295	0.06649649
52-430 X 54-520 F ₁ , 21	2	0	2	3	6	8	6	17	16	18	30	37	48	54	56	50	43	25	18	9	1	0	1		-0.006252±0.012284	0.05108333
54-520 X 52-305 F ₁ , 22	2	5	5	5	6	15	14	13	19	15	32	23	39	39	41	49	40	36	29	15	6	0	2		-0.035233±0.008540	0.07559220
A56-3, 23	5	2	5	4	9	7	10	12	19	16	29	24	43	52	51	47	35	40	24	11	5			-0.004910±0.011903	0.06768234	
54-520, 24	4	3	8	4	6	12	5	9	17	15	36	32	43	38	56	52	34	31	25	11	8	1		-0.117425±0.012112	0.06875872	

^{1/} Used to estimate the frequency distribution due to environmental variation.

For percentage sucrose, after transformation, the variance for the F_1 hybrid (52-430 X 52-307) is 0.00055446 and the mean is 1.249470, whereas the corresponding values for inbred 34 are 0.00087136 and 1.214010, respectively (see table 4). Again each of the within plot variances has 420 degrees of freedom and the F value is 1.57. The P value is less than 0.01. It is apparent that the difference between the variance of the F_1 hybrid and inbred 34 is not readily accounted for by chance fluctuation. This may be due to the fact that the F_1 hybrid is highest of all populations in percentage sucrose and therefore is more influenced by a possible ceiling. This possibility must be kept in mind when interpreting the data for percentage sucrose. That is, when using the F_1 hybrid frequency distribution to partition out the identifiable numbers of genetic deviates in the upper classes of the frequency distributions in group 1, the estimates would be expected to be somewhat too high for those populations having lower means than the F_1 . Likewise, for group 2 when using inbred 34 for the same purpose, the estimates of the identifiable numbers of genetic deviates would be somewhat too low for segregating populations having means larger than that of 34. That this probably is not serious for these data becomes apparent as the analysis of the transformed data proceeds.

Table 4.--Population frequency distributions adjusted to eliminate differences between replications within populations and differences between populations within groups, percentage sucrose, data transformed to logarithms.

Group and population	Class																							Mean and standard error	Total variance												
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23														
Group 1																																					
CMS X 4W-34, 1												1	0	4	7	27	49	98	152	80	25	6	1		1.219459±0.005111	0.00140614											
CMS X A54-1, 2												2	0	4	8	21	56	100	140	89	25	3	2		1.216107±0.004384	0.00146724											
A54-1, 3											1	1	1	2	5	27	57	91	138	95	24	8			1.226293±0.004704	0.00150786											
CMS X 4W-34 S ₂ , 4														2	6	20	51	120	142	86	20	3			1.233647±0.003441	0.00107642											
4W-34 S ₂ , 5										1	1	0	0	4	6	23	43	114	156	78	33	1			1.229650±0.004222	0.00138215											
CMS X 4W-34AR, 6													3	7	18	56	124	131	80	25	5	1			1.226420±0.004867	0.00117416											
4W-34AR, 7												1	7	19	46	123	162	123	162	72	19	1			1.239405±0.003840	0.00095125											
52-430 X 54-520 F ₁ , 8											1	0	0	4	11	62	122	151	80	19					1.230654±0.003685	0.00094006											
52-430 X 52-307 F ₁ , 9 1/2												1	0	0	4	41	148	189	60	7					1.249470±0.003562	0.00055446											
54-520 X 52-305 F ₁ , 10														2	15	60	126	146	82	18	1				1.226911±0.004117	0.00086282											
A56-3, 11														2	5	27	50	106	137	99	23	1			1.225587±0.005054	0.00113871											
54-520, 12															7	17	54	107	147	76	22	13			1.207243±0.004585	0.00168179											
Group 2																																					
CMS X 34, 13												2	8	12	60	117	139	82	24	6					1.210076±0.004868	0.00114111											
34, 14 1/2												1	0	4	11	51	124	167	76	14	2				1.214010±0.005643	0.00087136											
CMS X A54-1, 15												5	8	23	56	98	130	96	29	4	1				1.202076±0.004811	0.00137587											
A54-1, 16														1	0	0	1	0	3	6	10	17	52	91	136	92	32	9	1.218363±0.004443	0.00187436							
CMS X A58-5, 17																1	1	1	3	8	20	34	57	79	96	61	53	24	12	1.095809±0.006455	0.00304107						
A58-5, 18																1	0	0	1	2	2	4	8	18	28	31	57	59	54	69	42	28	20	16	9	0.949566±0.008901	0.00653163
CMS X A58-22, 19																																			1.192189±0.005066	0.00157941	
A58-22, 20																																		1.187068±0.005749	0.00244849		
52-430 X 54-520 F ₁ , 21																																		1.223603±0.005003	0.00091486		
54-520 X 52-305 F ₁ , 22																																		1.221524±0.003920	0.00101904		
A56-3, 23																																		1.221935±0.003481	0.00167110		
54-520, 24																																		1.199221±0.004148	0.00148426		

1/ Used to estimate the frequency distribution due to environmental variation.

Individual Plant Data

The discussion of the individual plant data will be followed by a discussion of the population means.

Univariate Frequency Distributions

The population univariate frequency distributions adjusted to eliminate differences between replications within populations and adjusted to eliminate differences between populations within groups for weight per root transformed to logarithms are listed in table 3. In studying the frequency distributions of this table, it is helpful to keep in mind that the frequency distributions of the F_1 hybrid (52-430 X 52-307) is used to estimate the frequency distributions, due to environmental variation for the populations of group 1, and that the frequency distribution of inbred 34 is used for the same purpose for the populations of group 2.

A study of the frequency distributions for the populations in group 1 of table 3 reveals that all of the other frequency distributions have more individuals in classes 10 and 18 than does the frequency distribution of the F_1 hybrid (52-430 X 52-307). Consequently, classes 10 and below are taken as those lower classes of the frequency distribution having some identifiable numbers of genetic deviates, and classes 18 and above as those of the frequency distribution having some identifiable numbers of genetic deviates in the upper classes of the frequency distribution. Since each frequency distribution is composed of the same number of individuals, namely 450, this F_1 hybrid frequency distribution can be employed to partition directly the identifiable numbers of genetic deviates in the lower and in the upper classes of the frequency distribution of any segregating population in group 1. This is a modification of the procedure used by Powers (8) and Powers et al. (11). The modification involves the adjustments employed to eliminate differences between replications within populations and differences between populations.

For group 2, using the frequency distribution of inbred 34 as an estimate of the environmental variability, the lower classes having some identifiable numbers of genetic deviates are found to be 11 and below and the upper classes are found to be 17 and above. Since the frequency distributions of table 3 are derived from the original values transformed to logarithms and adjusted to eliminate differences between replications and differences between populations, any frequency distribution in group 1 is directly comparable to any other frequency distribution in this same group. The same is true of the frequency distributions in group 2.

To illustrate, consider the frequency distributions of CMS X 34 and 34. Totaling for both frequency distributions gives values of 108 and 90 for the lower classes, 241 and 291 for the middle classes, and 101 and 69 for the upper classes. Subtracting the appropriate values shows that the identifiable number of genetic deviates in the lower classes is fluctuating around 18 and the identifiable number of genetic deviates in the upper classes is fluctuating around 32. The difference for the middle class is -50. Chi square can be used to determine the probability of these numbers (108 and 90, 241 and 291, and 101 and 69) being chance fluctuations from a common frequency distribution. The degrees of freedom are 2. By completing the necessary calculations chi square is found to be 12.359 and P is less than 0.01. Considerable confidence can be placed in the assumption that these values of 18, -50, and 32 are not chance fluctuations from zero, and therefore, that population CMS X 34 has 32 ± 5 superior genetic deviates in the upper classes. The standard error 5 is obtained from application of the formula; the standard error = \sqrt{pqn} , in which $q = 32/450$ and $p = 1-q$, and finally, n is the number in the sample, in this case 450.

Taking another example, whether CMS X A58-22 and A58-22 populations differ can be tested directly by comparing the two frequency distributions. The comparable numbers in the lower, middle, and upper classes of the frequency distributions are 115 and 118, 223 and 211, and 112 and 121. In this case the value of chi square is 0.718. The degrees of freedom are 2 and P is greater than 0.05. The differences in numbers noted are readily accounted for by chance fluctuation. It follows that these two populations do not differ significantly in identifiable numbers of genetic deviates. However this finding must not be taken as evidence that they do not differ in other respects.

To determine whether they do differ in other respects the means corresponding standard errors, and variances of table 1 should be studied. These are the nonadjusted and nontransformed data. A study of the means, their standard errors, and the frequency distributions of table 3 for populations CMS X A58-22 and A58-22 reveals that the former is significantly higher in mean weight per root. This in turn provides valuable information concerning the location of the identifiable numbers of superior genetic deviates. More of the identifiable number of genetic deviates would fall in the higher classes of the frequency distribution for the nonadjusted data of population CMS X A58-22 than would be the case for the frequency distribution of population A58-22. Such being the case, population CMS X A58-22 would be superior to population A58-22 for breeding purposes even though the identifiable numbers of superior genetic deviates are essentially the same for both populations. In other words, proper breeding procedures should result in comparable advances in both populations, but due to the average superiority of the individuals in population CMS X A58-22, this population should give superior results to population A58-22 as

regards weight per root. It is clear that in order to properly evaluate the breeding potential of populations the means from the nonadjusted data need to be studied along with the adjusted frequency distributions.

The frequency distributions for percentages of sucrose transformed to logarithms and adjusted to eliminate differences between replications within populations and differences between populations are listed in table 4. As was done for weight per root, the frequency distribution of the F_1 hybrid (52-430 X 52-307) is taken as an estimate of the frequency distribution attributable to environmental variation for the populations of group 1. For the populations of group 2 the frequency distribution of inbred 34 serves a similar purpose.

For group 1, the F_1 hybrid (52-430 X 52-307) has fewer individuals in class 17 and lower classes than does any other population. Also, this is true of class 20 and higher classes. For group 2, inbred 34 has fewer individuals in class 15 and lower classes than any other population with the exception of population 52-430 X 54-520. For the higher classes the break occurs in class 19. Then for group 1 the identifiable numbers of genetic deviates occur in class 17 and lower classes and class 20 and higher classes; and for group 2 in class 15 and lower classes and in class 19 and higher classes. These lines of demarcation for percentage sucrose for groups 1 and 2 are fairly definite (see table 4). The same was true for weight per root (see table 3). This supports previous findings (Powers, 8 and Powers et al. 10 and 11).

Now, the data from these various experiments are sufficiently broad in scope of material and sufficiently extensive to justify the conclusion that this method of dividing the frequency distributions of segregating populations into lower, middle, and upper classes to estimate the identifiable numbers of genetic deviates in the lower and upper classes of the frequency distributions is biologically sound.

Total within-plot and genetic variances, heritability ratios, and identifiable numbers of genetic deviates

The total within-plot and genetic variances, heritability ratios, and identifiable numbers of genetic deviates with their standard errors for weight per root and percentage sucrose are listed in table 5. For group 1, the F_1 hybrid (52-430 X 52-307) is used to estimate the total within-plot variance due to environmental variation. Inbred 34 serves a similar purpose for group 2. Whether any of the total within-plot variances differ significantly from each other can be determined by using Snedecor's F test. The degrees of freedom for the within-plot total variances are 420.

✓ Used as an estimate of environmental variance.

Before proceeding with the discussion of the data in table 5, it is desirable to determine what confidence can be placed in differences noted. For example, if the total within-plot variance of a given population is significantly larger than the estimate of the variance attributable to environmental variation, then the corresponding genetic variance and heritability ratio are significantly different from zero. Hence, both become meaningful. For example, the F_1 hybrid (52-430 X 54-520) has a total within-plot variance of 0.05739611 and the F_1 hybrid (52-430 X 52-307) used to estimate environmental variation has a total within-plot variance of 0.04510436. The corresponding F value $(0.05739611 \div 0.04510436)$ is 1.27. The degrees of freedom are 420 for both variances. The odds are greater than 99:1 against these variances being chance deviations from a common value. It follows that both the genetic variance of 0.01229175 and the heritability ratio of 0.21415650 are significantly different from zero.

Also, it is informative to determine what confidence can be placed on differences between genetic variances and differences between heritability ratios. Again, if the two total within-plot variances for any two populations are significantly different, then it follows that the corresponding genetic variances differ significantly from each other and the same is true of the corresponding heritability ratios. For example, it may be informative to determine whether the genetic variance and heritability ratio are greater for the stock beet A58-5 than for its hybrid with CMS. The value of F is $(0.06517320 \div 0.05431556)$, see table 5) or 1.20. The odds are greater than 19:1 against these genetic variances being chance fluctuations from a common variance. The same holds true for the heritability ratios. Hence, considerable confidence can be placed on the deduction that the genetic variance of CMS X A58-5 is greater than that of the stock beet A58-5. Also, the same degree of confidence can be placed on the deduction that the heritability ratios differ significantly.

With this information, the heritability ratios and the identifiable numbers of genetic deviates can be studied more advantageously. The heritability ratios are the values obtained by dividing the genetic variances by the total within-plot variances. The genetic variances are obtained by subtracting the estimate of the environmental variance from the total within plot variance. In group 1, the variance of the F_1 hybrid (52-430 X 52-307) was used to estimate the environmental variance and, in group 2, inbred 34 was used for this purpose.

The identifiable numbers of genetic deviates are indicated as superior, inferior, and total (superior + inferior) in table 5. The method of calculating these values will be illustrated for weight per root and population CMS X 4W-34 of group 1 (see table 3). The number of individuals falling in classes of 18 and above for the F_1 hybrid (52-430 X 52-307) is 21 and the number of individuals falling in class 10 and in lower classes is 76. The

numbers of individuals falling in these same classes for CMS X 4W-34 are 60 and 118. Hence, the identifiable number of superior genetic deviates is $60 - 21$ or 39. The identifiable number of inferior genetic deviates is $118 - 76$ or 42. It follows that the total identifiable numbers of genetic deviates are 39 (superior), 42 (inferior) and 81 (total) as shown in table 5. The other values for the identifiable numbers of genetic deviates listed in table 5 were calculated in an identical manner.

The association between the heritability ratios and the identifiable numbers of genetic deviates is studied by employing correlation. Consider first these values for weight per root (see table 5). According to theory and on the basis of normalcy, the heritability ratios should be rather closely associated with the identifiable numbers of superior genetic deviates. That is, the larger the heritability ratio the larger should be the identifiable number of superior genetic deviates. An examination of the data under the column headings, heritability ratio and identifiable number of genetic deviates, reveals that there are positive relations between these two constants for both weight per root and percentage sucrose. This is true also of the comparisons involving the heritability ratios and the inferior and the total identifiable numbers of genetic deviates. A further study of the data shows that the deduction holds for the comparison involving characters.

The degree of association as regards comparisons within groups can be determined by employing correlation procedures. The correlation coefficients between heritability ratios and the identifiable numbers of genetic deviates for superior, inferior, and total are listed in table 6. The characters are weight per root and percentage sucrose. The correlation coefficients were calculated from the data listed in table 5.

Table 6.--Simple correlation coefficients between heritability ratios and the identifiable numbers of genetic deviates for superior, inferior, and total of the univariate frequency distributions; the characters being weight per root and percentage sucrose.

Group	Weight per root						Percentage sucrose					
	Superior		Inferior		Total		Superior		Inferior		Total	
	r	r ² (100)	r	r ² (100)	r	r ² (100)	r	r ² (100)	r	r ² (100)	r	r ² (100)
1	0.77	59	0.81	66	0.84	71	0.72	52	0.76	58	0.76	58
2	0.92	85	0.80	64	0.93	86	0.91	83	0.91	83	0.92	85

A study of table 6 reveals that the least amount of the variation accounted for by correlation is 52 percent and the greatest is 86 percent. The values are consistently higher for group 2 than they are for group 1. For weight per root the associations are higher for the identifiable numbers of superior and total genetic deviates than they are for the inferior. However, for percentage sucrose the degrees of associations within groups do not differ materially. Hence the percentages of the variation of the identifiable numbers of genetic deviates accounted for by regression with the heritability ratios are high as compared with biological data in general.

It follows that the estimates of identifiable numbers of genetic deviates in the frequency distributions of populations are reliable. They are of considerable value to both geneticists and plant breeders in population genetic studies. When studied in conjunction with the means they provide the plant breeder with considerable information about the breeding potential of populations.

Bivariate Frequency Distributions

The methods and procedures for partitioning out the identifiable numbers of genetic deviates in upper and lower classes of the univariate frequency distribution have been given in some detail. This section of the paper gives the methods and procedures for partitioning out the identifiable numbers of genetic deviates in the upper and lower classes of the bivariate frequency distributions of segregating populations.

The bivariate frequency distributions for weight per root and percentage sucrose for populations F_1 hybrid (52-430 X 52-307) and A54-1 are given in tables 7 and 8, respectively. The data are for group 1. As was the case for the univariate frequency distributions given in tables 3 and 4, the bivariate frequency distributions listed in tables 7 and 8 have been adjusted to eliminate differences between replications within populations and to eliminate differences between populations within groups. Again, for the group 1 populations, the F_1 hybrid is used to estimate the bivariate frequency distribution due to environmental variation. Inbred 34 is used for the same purpose for the populations of group 2.

Table 7.—Bivariate frequency distribution adjusted to eliminate differences between replications within populations and differences between populations within groups; group 1, data transformed to logarithms, 52-430 X 52-307 Fl, weight per root in kilograms and percentage sucrose.

Sucrose, class	Weight, class																						Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
22														(6)									0
21											1	1	2	1	1	1						(5)	7
20				1	0	1	1	3	2	2	13	12	6	6	7	5	1						60
19	2	1	0	0	2	2	3	8	7	10	21	26	26	23	28	16	7	5	2			(4)	189
18	1	1	0	1	2	7	1	3	4	4	9	20	16	22	17	17	17	3	3			148	
17	1	1	0	0	0	0	1	1	1	0	2	2	3	5	6	5	6	3	4				41
16							1	0	0	0	0	0	0	0	0	1	1	1					4
15																							0
14																							0
13	1																						1
12																						(3)	0
11														(2)									0
Total	5	3	0	2	4	10	7	15	14	16	46	61	53	57	59	45	32	12	9				450

1/ The figures in parentheses are the nine sections of the frequency distribution.

Table 8.—Bivariate frequency distribution adjusted to eliminate differences between replications within populations and differences between populations within groups; group 1, data transformed to logarithms, A54-1, weight per root in kilograms and percentage sucrose.

Sucrose, class	Weight, class																						Total
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	
22							1	0	1	2	0	0	0	1	1	2							8
21											2	3	3	2	1	1	2						(5) 24
20											12	12	8	10	9	4	8	3					95
19											15	12	11	15	14	17	9	5	2	3	1		138
18											4	7	11	(9) 10	6	12	6	7	2	1	1	1	(4) 91
17											3	3	7	7	6	5	6	4	3	4	1	1	57
16											2	0	0	1	1	3	4	2	3	4	2		27
15											0	0	0	0	2	0	0	0	0	2			5
14																		1	0	1		(3) 2	
13													1										1
12																	1						1
11																							1
Total	3	7	4	4	10	16	8	13	23	26	38	38	40	(2) 46	40	45	35	21	11	14	6	2	450

✓ The figures in parentheses are the nine sections of the frequency distribution.

At this time, it seems desirable to point out that other lines of demarcation of the univariate and bivariate frequency distributions may be more informative than those shown in tables 7 and 8. For example, some sugarbeet breeders, as regards weight per root, may be interested in class 20 and higher classes and, as regards percentage sucrose, in class 22 only. Hence, in such an event, only the univariate frequency distributions are involved. For the bivariate frequency distributions, it is quite probable that some breeders would be interested in the number of individuals in a section including class 17 and higher classes for weight per root, and class 19 and higher classes for percentage sucrose. The total number of individuals in such a section of the bivariate frequency distribution of tables 8 is 33 and of table 7 is 15. Hence, the identifiable number of genetic deviates is 33 - 15, or 18. It is evident that breeders can choose lines of demarcation best suited to their purposes and apply the methods and procedures set forth in this article to a study of the frequency distributions.

An examination of tables 7 and 8 show that two vertical and two horizontal lines divide each table into nine different sections. The method of determining the locations of these lines is the same as that given for the univariate frequency distributions and hence will not be repeated here. In fact the locations of the lines are taken from tables 3 and 4. The sections are given numbers from 1 to 9 moving counter-clockwise with number 9 being the center section. The section numbers are shown in parentheses in each section. With characters such as weight per root and percentage sucrose in which the higher values represent, economically, the more desirable individuals, these 9 sections of the bivariate frequency distribution may be described as follows (see table 8).

- | | |
|------------|--|
| Section 1: | Inferior for weight and inferior for sucrose |
| " 2: | Average for weight and inferior for sucrose |
| " 3: | Superior for weight and inferior for sucrose |
| " 4: | Superior for weight and average for sucrose |
| " 5: | Superior for weight and superior for sucrose |
| " 6: | Average for weight and superior for sucrose |
| " 7: | Inferior for weight and superior for sucrose |
| " 8: | Inferior for weight and average for sucrose |
| " 9: | Average for weight and average for sucrose |

It is evident that the most desirable individuals as regards these two characters fall in section 5 and the least desirable in section 1. It is equally evident that the second most desirable individuals fall in sections 4 and 6, if weight per root and percentage sucrose are considered equal in assessing desirability. It follows from the same reasoning that the second least desirable individuals fall in sections 2 and 8. The number of individuals for populations of group 1 in each section of the bivariate frequency distribution for weight per root and percentage sucrose and totals of sections 4, 5, and 6 and of 1, 2, and 8 are listed in table 9. The original data for both characters were transformed to logarithms.

Table 9.—Number of individuals for populations of group 1 in each section of the bivariate frequency distribution for weight per root and percentage sucrose, data transformed to logarithms, and totals of sections 4, 5, and 6 and of 1, 2, and 8.

Population and entry number	Section									Total of sections	
	1	2	3	4	5	6	7	8	9	4,5,6	1,2,8
	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.	No.
CMS X 4W-34, 1	15	48	25	28	7	61	44	59	163	96	122
CMS X A54-1, 2	10	53	28	21	7	61	51	55	164	89	118
A54-1, 3	14	52	28	23	3	81	43	57	149	107	123
CMS X 4W-34 S ₂ , 4	13	47	19	21	0	66	43	54	187	87	114
4W-34 S ₂ , 5	15	43	20	40	9	67	36	68	152	116	126
CMS X 4W-34AR, 6	9	52	23	21	4	68	39	54	180	93	115
4W-34AR, 7	21	32	20	39	6	59	27	68	178	104	121
52-430 X 54-520 F ₁ , 8	6	51	21	22	2	50	47	60	191	74	117
52-430 X 52-307 F ₁ , 9 1/	7	31	8	13	0	57	10	59	265	70	97
54-520 X 52-305 F ₁ , 10	25	33	19	36	5	58	38	61	175	99	119
A56-3, 11	11	52	21	28	8	70	45	63	152	106	126
54-520, 12	22	48	15	22	4	81	26	58	174	107	128

1/ Used as an estimate of the environmental frequency distribution.

The reason for grouping sections 4, 5, and 6 and for grouping 1, 2, and 8 is that, after subtracting the number of individuals due to environment from the individuals in section 5 and doing the same for section 1, the majority of the values for the various populations (see table 9) are less than 10, and hence the problem of small numbers arises. This problem is largely avoided by grouping classes 4, 5, and 6 as the superior identifiable numbers of genetic deviates and 1, 2, and 8 for the inferior.

It will be remembered that the frequency distribution of the F_1 hybrid (52-430 X 52-307) was used to estimate the frequency distribution attributable to environmental variation. This population has 70 individuals in sections 4, 5, and 6 (superior) and 97 individuals in sections 1, 2, and 8 (inferior). These, respectively, are subtracted from the corresponding values of the segregating populations to give the identifiable numbers of genetic deviates in table 10 under the column headings "Superior, sections 4, 5, and 6" and "Inferior, sections 1, 2, and 8". The sums of numbers for superior and inferior give the identifiable numbers of genetic deviates under column heading "Total". The heritability ratios for weight per root and for percentage sucrose are listed in columns 2 and 3 of table 10. The method of calculating these heritability ratios and determining their reliability is given in table 5 and the discussion of that table.

A study of table 10 reveals that there is an association between the magnitude of the heritability ratios and the size of the identifiable numbers of genetic deviates listed as superior, inferior, and total. On an average, as the heritability ratios increase the identifiable numbers of genetic deviates increase also.

The degrees of the associations are determined by multiple correlation techniques. The multiple correlation coefficients are listed in table 11.

Table 11.--Multiple correlation coefficients between heritability ratios and the identifiable numbers of genetic deviates for superior, inferior, and total of the bivariate frequency distributions; the characters being weight per root and percentage sucrose.

Group	Superior		Inferior		Total	
	R	R ² (100)	R	R ² (100)	R	R ² (100)
1	0.77	59	0.60	36	0.74	55
2	0.90	81	0.64	41	0.83	69

Table 10.—For weight per root and percentage sucrose, heritability ratios and identifiable numbers of genetic deviates in sections 4, 5, and 6 (superior) and in sections 1, 2, and 8 (inferior) and total for the bivariate frequency distributions adjusted to eliminate differences between replications and to eliminate differences between populations, data transformed to logarithms, groups 1 and 2.

Group and population	Heritability ratio		Identifiable numbers of genetic deviates		
	Weight	Sucrose	Superior	Inferior	Total
			sections 4,5,6	sections 1,2,8	
			No.	No.	No.
Group 1					
CMS X 4W-34, 1	0.33113266	0.60568649	26±5	25±5	51±7
CMS X A54-1, 2	0.29655992	0.62210681	19±4	21±4	40±6
A54-1, 3	0.35813254	0.63228438	37±6	26±5	63±7
CMS X 4W-34 S ₂ , 4	0.31225300	0.48489888	17±4	17±4	34±6
4W-34 S ₂ , 5	0.41208572	0.59884238	46±6	29±5	75±8
CMS X 4W-34AR, 6	0.23589192	0.52778156	23±5	18±4	41±6
4W-34AR, 7	0.36034351	0.41712484	34±6	24±5	58±7
52-430 X 54-520 F ₁ , 8	0.21415650	0.41018658	4±2	20±4	24±5
52-430 X 52-307 F ₁ , 9 ^{1/}					
54-520 X 52-305 F ₁ , 10	0.44104908	0.35737880	29±5	22±5	51±7
A56-3, 11	0.34029800	0.51308059	36±6	29±5	65±7
54-520, 12	0.22301232	0.67031556	37±6	31±5	68±8
Group 2					
CMS X 34, 13	0.23144535	0.23639264	21±4	15±4	36±6
34, 14 ^{1/}					
CMS X A54-1, 15	0.41701352	0.36668435	36±6	29±5	65±7
A54-1, 16	0.40616748	0.53511599	39±6	14±4	53±7
CMS X A58-5, 17	0.37331449	0.71346927	32±5	21±4	53±7
A58-5, 18	0.24804052	0.86659379	38±6	21±4	59±7
CMS X A58-22, 19	0.31834814	0.44830031	30±5	9±3	39±6
A58-22, 20	0.38578563	0.64412352	43±6	21±4	64±7
52-430 X 54-520 F ₁ , 21	0.20046129	0.04754826	14±4	5±2	19±4
54-520 X 52-305 F ₁ , 22	0.45969161	0.14492071	44±6	32±5	76±8
A56-3, 23	0.39654716	0.47857100	37±6	12±3	49±7
54-520, 24	0.40599389	0.41293304	36±6	31±5	67±8

^{1/} Used as an estimate of environmental variance.

A study of the data in table 11 reveals that the least amount of the variability of identifiable numbers of the genetic deviates accounted for by multiple correlation is 36 percent and the greatest is 81 percent. Again, comparatively speaking and as regards biological data, the percentages of the variability of identifiable numbers of genetic deviates accounted for by multiple correlation are high. It follows that partitioning the frequency distributions to determine the numbers of identifiable genetic deviates provides a reliable method of studying such data. The partitioning of bivariate frequency distributions is of value to the plant breeder in determining the comparative breeding potential of populations. Again the means must be studied in conjunction with the identifiable numbers of genetic deviates in order to evaluate populations.

Population Means

In 1856 Louis de Vilmorin (13) introduced the progeny test as a method of plant breeding. Hjalmar Nilsson (6) adopted the progeny test as a method of breeding wheat at the Svalof Experiment Station in Sweden. Here it became known as the pedigree method of breeding and has become widely used throughout the world. One reason for its popularity lies in the fact that means of progeny are used to evaluate their worth and means are much more reliable than data from individual plants. The means of the logarithms of the 24 populations are listed in tables 3 and 4. These will be studied next.

The analyses of variance of means of logarithms for weight per root and means of logarithms for percentage sucrose are given in table 12 for groups 1 and 2. The means are analyzed on the basis of duplicate entries and the basis of all populations. The duplicate entries provide an estimate of the magnitude of environmental variance that is included with the differences between means of populations, whereas the differences between populations provide an estimate of the magnitude of the variance attributable to both environmental and genetic causes. A comparison of the F values listed under populations (see table 12) shows that in no case are the differences between means of duplicate entries greater than would be expected due to chance. Hence, it may be concluded that the duplicate entries provide a valid estimate of the magnitude of environmental variance. A comparison of the obtained F values with those for the 5-percent level listed under populations shows that the differences between the means of all populations are not readily explained by chance. This is true for both weight per root and percentage sucrose. This shows that a considerable portion of the variance due to differences between population means is attributable to genetic causes.

A comparison of the interaction variance for duplicate entries with those for all populations furnishes further information of value in the interpretation of the data. The only F value approaching significance is the one for percentage sucrose of group 2. The F value obtained by dividing the interaction variance for all populations by the interaction variance for duplicate entries is 1.95. This F value is significant at the 1-percent level. Even so, it is very small compared with 0.19120919, the variance attributable to differences between means of populations. Hence, these interaction variances provide a reliable estimate of that portion of the total variance attributable to environmental causes.

The detailed data essential to calculation of the genetic variances and heritability ratios are listed in table 13. A study of the heritability ratios of this table reveals that they are extremely high. It can be concluded that as regards the conditions of this experiment, and for all practical purposes, the environmental variability is negligible. In other words, a great deal of confidence can be placed in the differences noted between population means. It furnishes further information as to why progeny tests are so reliable, and hence, why the pedigree method of breeding has been so universally accepted.

Table 13.--Total, environmental, and genetic variances, and heritability ratios for weight per root and percentage sucrose based on differences between population means.

Character and group	Variance			Heritability ratio
	Total ^{1/}	Environmental ^{2/}	Genetic	
Weight per root				
Group 1	0.08057947	0.00369724	0.07688223	0.95411685
Group 2	0.32627703	0.00442003	0.32185700	0.98645314
Percentage sucrose				
Group 1	0.00351305	0.00031609	0.00319696	0.91002405
Group 2	0.19120919	0.00049884	0.19071035	0.99739113

^{1/} The degrees of freedom are 11.

^{2/} The degrees of freedom are 319.

Conclusions and Summary

1. The method and procedures employed in partitioning the univariate and bivariate frequency distributions into identifiable numbers of genetic deviates are given in some detail and are illustrated.
2. Individual plant data are adjusted so as to eliminate differences between replications and differences between populations. By so doing frequency distributions are directly comparable and no assumptions concerning type of curve (normal or otherwise) are necessary.
3. The original plant data for both weight per root and percentage sucrose were transformed to logarithms. For weight per root this effectively removed the positive relation between the means and variances. There was no consistent relation between the means and variance for percentage sucrose. The only tendency noted was for the extremely high mean percentage sucrose values to be accompanied by somewhat lower variances. This tendency did not materially interfere with the analysis and interpretation of the data for percentage sucrose.
4. The identifiable numbers of genetic deviates for both the univariate frequency distribution and the bivariate frequency distribution are rather closely associated with the magnitude of the heritability ratios.
5. Using the partitioning method of genetic analysis to determine the identifiable numbers of genetic deviates has its greatest value to the plant breeder in studying frequency distributions based on individual plant data involving comparatively large numbers.
6. The heritability ratios are more valuable in studying means of populations of progenies or means of families. This is particularly true of those studies in which the number of replications is sufficient to provide fairly reliable estimates of the means. Usually due to the limitations placed on the number of progenies or families that it is possible to include in the studies, the partitioning of progeny, or family, frequency distributions into identifiable numbers of genetic deviates does not provide much information. This is so because of the small numbers in each class.
7. The partitioning of frequency distributions into identifiable numbers of genetic deviates and the components of variance method of studying populations are supplemental. They should not be considered as mutually exclusive. Both contribute to an understanding of the genetic composition of populations and to the evaluation of their breeding potentials.

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P A R T VII

POLYPLOIDY IN RELATION TO ROOT YIELD,
SUCROSE PERCENTAGE, AND DISEASE RESISTANCE

- - - - -

INTERSPECIFIC HYBRIDIZATION
and
STUDIES ON TETRAPLOIDY

Foundation Project 11

Helen Savitsky

V. F. Savitsky

POLYPLOIDY IN SUGARBEETS

Combining Ability in Tonnage and Sucrose in Single-cross and Three-way Diploid, Triploid, and Tetraploid Male-sterile Monogerm Hybrids.

V. F. Savitsky

Materials and Methods.

Combining ability in diploid, triploid, and tetraploid single-cross and three-way hybrids was studied. Self-fertile and self-sterile stocks were used for hybridization. Parental stocks with minimum and maximum expression of yielding ability, percent sucrose and curly top resistance were chosen. The role of genetic diversity served as a supplementary factor in selection of parental stocks for production of male sterile monogerm hybrids.

The triploid male-sterile monogerm hybrids were obtained after hybridization of diploid male-sterile strains with 2 types of tetraploid pollinators. Some pollinators were tetraploid populations obtained by H. Savitsky after colchicine treatment. The others were tetraploid hybrids between different tetraploids previously obtained by colchicine treatment. Advanced generations of these tetraploid hybrids were used for production of three-way hybrids with the purpose to study the possibility of substitution of the single-cross hybrids for the three-way hybrids. The three-way hybrids may be of importance in several cases. They are especially important when the combining of more than 2 characters is pursued (for example - resistance, yield, percent sucrose) at the level which is close to their highest expression.

The tetraploid male-sterile monogerm hybrids were obtained from hybridization of tetraploid male-sterile monogerm strain with tetraploid pollinators.

Hybridization of male-sterile monogerm strains with diploid and tetraploid pollinators was conducted on separate isolations.

The experiment included 28 populations (9 diploid, 7 triploid, and 12 tetraploid) which were planted in 10 replications in randomized complete block design.

The experimental plots were planted April 3 and harvested October 17, 1963. The previous crop was barley. Fertilization consisted of 1000 pounds of 10-10-5 fertilizer per acre as a preplant application and 2 side dressings of 400 pounds of 16-20 mixture per acre.

Table 1... Mean squares, degrees of freedom, and sources of variation in analysis of variance for percent sucrose and weight of roots.

Sources of Variation	Tons of roots			F		Percent sucrose			F	
	Degrees freedom	Sum of Squares	Mean Squares	Variance Ratio		Sum of Squares	Mean Square	Variance Ratio	005	001
Total sum of square	279	24820.997	-	-	-	299.290	-	-	-	-
Between blocks	9	882.032	98.004	2.235	1.92	12.479	1.386	3.811	1.92	2.50
Between Populations	27	13285.597	492.059	11.22	1.57	198.400	7.348	20.198	1.57	1.88
Residual (error)	243	10653.368	43.8410	-	-	88.411	0.368	-	-	-

Single-row plots were used and the plots were spaced 28 inches apart. Irrigations were applied at 7-day intervals by furrows from time of planting. Plants were sprayed to control leaf minor. No bolting or curly top damage was observed in the experiments.

Degrees of freedom, sum of squares and sources of variation in analysis of variance of root weight and sucrose are shown in table 1. The table shows highly significant differences for populations in both characters because the F ratio for percent sucrose equaled 20.2 and for tonnage 11.2, while tabulated F at the 5-percent point level equaled 1.57 and at the 1-percent level, 1.88.

Experimental results

Monogerm male-sterile hybrids derived from crosses with curly top resistant self-fertile lines

Two self-fertile curly top resistant lines, monogerm 127 and multi-germ 168, were used for study of the combining ability at the diploid, triploid, and tetraploid levels.

Both tetraploid lines, 127 and 168, showed higher resistance to curly top than their diploid ancestors in tests in Utah.

Male-sterile monogerm hybrids from crosses with self-fertile monogerm inbred 127.*The majority of the monogerm diploid self-fertile inbreds do not exhibit good combining ability in tonnage when crossed with each other by the use of their male-sterile diploid equivalents. The same is true for the diploid inbred 127.

F₁ monogerm diploid male-sterile hybrid (code N 139) derived from hybridization of 2 monogerm inbreds had the lowest tonnage in comparison with the F₁ hybrids between monogerm and multigerm lines (table 2, 3, 4, 5, code 133, 146, 151, 132, 141).

The tetraploid equivalent (code 134) of the line 127 distinguished by a high grade of curly top resistance at Thatcher, Utah. This tetraploid inbred is significantly higher in percent sucrose than the diploid US 75, but is lower in yield (table 2).

In spite of this, the F₁ tetraploid hybrid (code 135) and also triploid "pure" monogerm F₁ male-sterile hybrid (code 152) exhibited heterosis in the weight of root. Percent sucrose in the diploid and triploid hybrids was the same (table 2).

*Sugarbeet Research, 1958 Report, page 8.

Table 2... Tonnage and sucrose in F₁MS monogerm diploid, triploid, and tetraploid hybrids derived from pollination by self-fertile inbred 127

Populations	Code N	Tons of roots	Percent sucrose
Tetraploid monogerm inbred 127 (pollinator)	134	14.9248	14.93
F ₁ tetraploid hybrid	135	17.5336	14.93
F ₁ triploid hybrid	152	22.5992	14.65
F ₁ diploid hybrid	139	16.4512	14.58
US 75 population	-	16.4088	14.10
msd at 5% point	-	2.47	0.53
lsd at 1% point	-	3.26	0.70

Table 3... Tonnage and sucrose in F₁ MS monogerm diploid, triploid, and tetraploid hybrids derived from pollination by self-fertile inbred 168.

Populations	Code N	Tons of roots	Percent sucrose
Tetraploid multigerm self-fertile inbred 168	155	13.3984	15.11
F ₁ tetraploid hybrids	153	17.2568	15.5
F ₁ triploid hybrids	154	21.1152	14.97
F ₁ diploid hybrids	133	18.7832	15.05
US 75	-	16.4088	14.10
msd at 5% point	-	2.47	0.53
lsd at 1% point	-	3.26	0.70

The F_1 triploid hybrid significantly exceeded in root weight, the F_1 diploid and the F_1 tetraploid hybrids. The yield of the diploid and tetraploid hybrids equaled the yield of US 75.

Thus, in this given case, the combining ability in yield appeared to be the highest in the triploid, then in tetraploid hybrids, and the lowest in the diploid male-sterile F_1 hybrids derived from crosses of 2 monogerm inbreds.

Male-sterile monogerm hybrids from crosses with multigerm inbred 168.

The tetraploid self-fertile multigerm inbred 168 (code 155) has the highest curly top resistance of 7 pollinator lines of F_1 hybrids which were studied in 1963. The tetraploid inbred 168, as well as its diploid ancestor, has small roots and an average percent sucrose (table 3).

In spite of this, the diploid F_1 hybrids derived from this inbred show heterosis in the weight of root and it significantly exceeded the yield of the tetraploid inbred 168 (code 155) and US 75. In percent sucrose this F_1 hybrid significantly exceeded US 75.

The tetraploid F_1 hybrid (code 153) was 1.5 tons lower in yield than the F_1 diploid hybrid (code 133), but 0.45% higher in sucrose.

The yield of the triploid F_1 male-sterile hybrid (code 154) was 2.34 tons higher than that of the F_1 diploid hybrid and 3.86 tons higher than the yield of the F_1 tetraploid hybrid. The difference in the yield of sugar between the triploid and tetraploid hybrids is less, because the F_1 tetraploid hybrid is higher in sugar.

Male-sterile monogerm hybrids from crosses with self-sterile multigerm populations. Diploid, triploid and tetraploid male-sterile monogerm hybrids obtained from crosses with 4 different populations were studied. One of these populations, derived from high-sucrose, self-sterile, variety Janasz. The tetraploid strain was produced from this population by H. Savitsky after colchicine treatment.

The 3 other populations were F_4 hybrids originating from hybridization of the same monogerm tetraploid line with different multigerm tetraploids. These multigerm tetraploid parental strains showed a good combining ability at the triploid level; i.e., the yield of the triploid hybrids obtained from them was higher than the yield of the corresponding diploid hybrids.

All 3 tetraploid F_4 hybrids had a good grade of curly top resistance and were used as pollinators for production of three male-sterile monogerm hybrids.

Table 4.--Tonnage and sucrose in F₁ MS monogerm diploid, triploid, and tetraploid hybrids derived from pollination by the self-sterile, high sucrose population of Janasz.

Populations	Code N	Tons of roots	Percent sucrose
Tetraploid multigerm parental population	143	19.8430	16.08
F ₁ tetraploid hybrid	147	21.0728	15.78
F ₁ triploid hybrid	145	23.1928	15.45
F ₁ diploid hybrid	146	19.2920	15.69
Diploid multigerm parental population	142	16.7056	16.18
US 75 (diploid)	-	16.4088	14.10
msd at 5% point	-	2.47	0.53
lsd at 1% point	-	3.26	0.70

Self-sterile multigerm high sucrose populations. During 2 years' testing at Salinas in 1962 and 1963 the parental variety Janasz and its monogerm male-sterile hybrids showed higher sucrose content than any other hybrids or populations used.

The average percent sucrose for 5 diploid, triploid, and tetraploid populations of Janasz in 1962 was 16.374, whereas the diploid variety US 75 in the same experiment produced only 14.40 percent sucrose.

Almost the same ratio was observed in the 1963 experiments with these selections (table 4). The average percent sucrose for 5 populations of Janasz was 15.836, whereas the percent sucrose in US 75 was 14.10. Differences in percent sucrose between Janasz hybrids and US 75 in the 1962 and 1963 tests were 1.9% and 1.7%, respectively.

During the 2-year period the diploid and the tetraploid populations of Janasz (code 142 and 143) showed higher sucrose than the diploid, triploid and tetraploid F_1 male-sterile monogerm hybrids (code 146, 145, and 147). See table 4.

The tetraploid population (code 143) gave a higher yield than the diploid population (code 142). According to our observations, the tetraploid population of Janasz shows better adaptiveness to our conditions than its original diploid population.

In the 1963 test, all 3 F_1 hybrids derived from Janasz had sucrose percent that exceeded the diploid check (US 75) by 1.4 to 1.7 percentage points. Among the hybrids the highest in sucrose was the tetraploid male-sterile hybrid, although the excess in percentage sucrose in this hybrid was not significant.

A comparative leveling of percent sucrose in the F_1 hybrids at different ploidy levels is probably caused by a very high root yield of the triploid male-sterile hybrids. Yield in the triploid hybrid (code 145) was 23.19 tons with 15.45 percent sucrose. The diploid F_1 hybrid (code 146) yielded 19.29 tons with 15.69 percent sucrose (table 4).

Maximum differences in the percent sucrose and yield in triploid male-sterile monogerm hybrids. The tetraploid population of Janasz was used for obtaining the highest possible percent sucrose in the triploid male-sterile monogerm hybrids. The triploid hybrid (code 145) exceeded by 1.4 percentage points the percent sucrose in the diploid US 75.

For obtaining the maximum yield in male-sterile monogerm triploid hybrids the progeny of hybrids between sugarbeets and fodder beets was used. Triploid hybrid (code 144) had 26.6696 tons of beets, but its

percent sucrose declined to 11.33; i.e., sucrose in this triploid hybrid was 2.67 percentage points lower than in the diploid US 75. Despite the enormous yield in this hybrid, which outyielded by 30% the best diploid and triploid F₁ hybrids, such hybrids will be of commercial value only after improvement in sugar content.

Monogerm male-sterile three-way hybrids derived from hybridization with 3 self-sterile hybrid populations.

Three self-sterile hybrid populations (code 156, 149, 136) derived from crosses of monogerm self-sterile tetraploid SLC 15 with 3 different multi-germ tetraploids (US 401, US 104, and US 35/2) were used as pollinators for production of triploid male-sterile hybrids. (See table 5.)

The triploid hybrids obtained in this way were three-way hybrids between male-sterile monogerm diploid stock and progenies of the above mentioned tetraploid hybrids. All 4 tetraploids involved in hybridization showed good combining ability in triploid male-sterile monogerm hybrids. This was one of the main reasons for their utilization in production of three-way triploid and tetraploid hybrids. The corresponding diploid hybrids were obtained from crosses of male-sterile monogerm with the same F₁ diploid hybrids which have been used at the tetraploid level (self-sterile SLC 15 x US 401, US 104 and US 35/2). In such a way the diploid, triploid and tetraploid hybrids had the same gene pool, but the dose of these genes varied in accordance with the ploidy levels.

Diploid three-way hybrids. All 3 diploid hybrids (code 151, 132, 141) exceeded in yield and in percent sucrose the check US 75. They did not differ from each other in yield, but the sucrose was considerably higher in the hybrids with US 35/2 than in the other 2 three-way diploid hybrids (table 5).

Tetraploid pollinators. All three tetraploid pollinators (code 156, 149, 136) used to obtain three-way hybrids distinguished by a good vigor. Their yield equaled or exceeded the yield of the diploid three-way hybrids. In sugar content they did not differ from the three-way diploid hybrids.

Tetraploid three-way hybrids. The tetraploid male-sterile monogerm three-way hybrids (code 138, 131, 140) obtained from the above mentioned pollinators gave the same yield as the tetraploid pollinators. The tetraploid hybrids derived from US 35/2 (code 138) showed higher sucrose than the pollinators or the diploid hybrids.

Table 5... Tonnage and sucrose in three-way MS monogerm diploid, triploid, and tetraploid hybrids, derived from pollination by self-sterile hybrid populations

Populations	Code N	Tons of roots	Percent sucrose
<u>Pollinator : monogerm 15 x US 35/2</u>			
Tetraploid parental population	156	20.5216	15.25
F ₁ tetraploid hybrid	138	22.9808	15.60
F ₁ triploid hybrid	150	22.7688	15.24
F ₁ diploid hybrid	151	19.5888	15.20
<u>Pollinator : monogerm 15 x US 104</u>			
Tetraploid parental population	149	22.7688	14.97
F ₁ tetraploid hybrid	131	20.9880	15.01
F ₁ triploid hybrid	137	23.2776	14.99
F ₁ diploid hybrid	132	18.9952	14.95
<u>Pollinator : monogerm 15 x US 401</u>			
Tetraploid parental population	136	20.8184	14.77
F ₁ tetraploid hybrid	140	19.5464	14.56
F ₁ triploid hybrid	148	23.1928	14.75
F ₁ diploid hybrid	141	19.9704	14.58
US 75 (diploid)		16.4088	14.10
msd at 5% point		2.47	0.53
lsd at 1% point		3.26	0.70

Triploid three way hybrids. All 3 triploid three-way hybrids (code 150, 137, 148) in spite of a good yield did not differ in percent sucrose from the diploid three-way hybrids (table 5) all three-way triploid hybrids exceeded in yield the diploid three-way hybrids. The triploid hybrids derived from US 401 and from US 104 significantly exceeded in yield the tetraploid three-way hybrids.

Conclusion

1. Combining ability for yield and percent sucrose varied in monogerm male-sterile hybrids depending on ploidy level (diploid, triploid, tetraploid).
 2. Changes in combining ability at different ploidy levels were observed in self-fertile and in self-sterile strains, and also in single-cross and in three-way hybrids.
 3. Many tetraploid populations, or single and three-way hybrids, did not exhibit the tetraploid depression under California conditions. Some tetraploid male-sterile monogerm hybrids outyielded the diploid monogerm hybrids and exceeded the triploid hybrids in percent sucrose.
 4. In the 1963 experiments the combining ability for yield was the highest in triploids, but combining ability for percent sucrose was the highest in some tetraploids.
 5. The tetraploid hybrids propagated during several generations may be used as tetraploid pollinators for production of three-way triploid male-sterile monogerm hybrids. This permits the use of any tetraploid lines for pollination of diploid male-sterile beets, regardless of whether these lines carry the genes recovering pollen fertility in F_1 male-sterile hybrids.
- For production of three-way hybrids in the diploid beets it is necessary that one of the three lines, the F_1 hybrid of which will serve as a second pollinator, carries the genes restoring pollen fertility in F_1 male-sterile hybrids, or that 2 lines produce a completely male-sterile F_1 progeny which will be pollinated by the third line.

EFFECT OF HYBRIDIZATION AND SELECTION FOR CURLY TOP AND LEAF SPOT RESISTANCE, AND OTHER TRAITS ON CURLY TOP AND LEAF SPOT RESISTANCE IN TETRAPLOID SUGARBEET STRAINS.

by V. F. Savitsky, Helen Savitsky, and Albert M. Murphy.

Application of new methods for increase of disease resistance in sugarbeet populations is of a great importance. Variability in the grade of resistance may be caused by the action of individual genes, by the complex of genes, or by changes in genome numbers (ploidy levels). Any of these factors can be used in sugarbeet breeding and in industry, although the breeding methods will be different.

In the history of sugarbeet breeding, selection for resistance to any disease was based on the conventional breeding of diploid biotypes and on selection of the most resistant self-sterile plants; seldom on self-fertile plants, or lines.

Experimental results obtained during recent years indicate that not only diploid, but also tetraploid sugarbeets may be used for improvement in disease resistance. Doubling of chromosomes changes genetic variability of curly top resistance. Genetic pool of the same original genes shows a different expression of curly top resistance at diploid and at tetraploid levels in many varieties.

The improved grade of curly top resistance caused by doubling of chromosomes is not the same in different populations and lines. The variety US 401 showed a positive reaction on chromosome doubling in respect to curly top resistance. Under the conditions of severe curly top infection at Jerome (Idaho) in 1958, 1959 and 1960, and at Thatcher (Utah) in 1962 and 1963, the diploid variety US 401 was almost completely destroyed by curly top. The tetraploid population of US 401 was also damaged, but not in the same degree.

Under such conditions the grade of curly top severity varied for the diploid US 401 from 8 to 10, and for the tetraploid US 401 from 2 to 7, on a basis of 10 points in ascending order of severity.

The original US 401 is a commercial leaf spot resistant variety; therefore, the tetraploid population US 401 was used not only for study of its resistance to curly top but also for evaluation of leaf spot resistance in different lines derived from this variety.

For this purpose within the tetraploid population of US 401, selection for curly top and leaf spot resistance was conducted under conditions of artificial infestation. Also, some plants were selected for characteristics such as vigor and dry matter. Every selection was made under conditions excluding infestation by another disease or selection for any other

character. The beets selected for curly top resistance in Twin Falls (Idaho), or for leaf spot resistance in Fort Collins (Colorado) were shipped to Salt Lake City (Utah) or to Salinas (California) for propagation. The tetraploid self-sterile monogerm line with a medium grade of curly top resistance, but susceptible to leaf spot, was crossed to tetraploid US 401. The true F_1 hybrids were propagated and the F_2 lines were chosen at random and propagated twice in curly top and leaf spot free conditions.

These tetraploid lines permitted the study of resistance to curly top and to leaf spot in the same lines during 1962 and 1963. The following tetraploid lines were studied: a/ eight lines selected in tetraploid US 401 for curly top resistance in Salt Lake City, Utah; b/ seven lines selected in tetraploid US 401 for leaf spot resistance in Fort Collins, Colorado; c/ seven lines selected in tetraploid US 401 for vigor and dry matter; and d/ six tetraploid F_4 hybrids derived from crosses of a monogerm line with medium grade of curly top resistance to tetraploid US 401.

In the experiment were included (as checks) diploid US 401, the original tetraploid population of US 401, the highly leaf spot resistant multigerm variety US 201, the highly leaf spot resistant monogerm diploid inbred S-23, US 35/2 and a European variety susceptible to both curly top and leaf spot.

Tests for leaf spot resistance were performed by J. A. Elder and J. O. Gaskill in Fort Collins, Colorado, in 1962 and 1963. Plantings were made in 2-row plots in a randomized block design in 3 replications. Artificial inoculation and frequent sprinkling were employed to promote development of leaf spot. The August 27, 1962, and August 29, 1963, readings were made at the approximate peak of the epidemic by J.A. Elder. (Table 1)

Test for curly top resistance in 1962 and 1963 was performed by A.M. Murphy at Thatcher, Utah. Tetraploid lines were randomized in single-row plots (150 feet long). The curly top exposure was increased by planting of test population and planting susceptible beets (Klein) about 2 months earlier than the test planting. Virulent strains of curly top virus were introduced by transplanting diseased beets selected the previous year. Readings of curly top severity were made by V.F. Savitsky September 11-14, 1962, and October 3-6, 1963. Each plot was given a general evaluation. Readings were made also for each individual plant in all plots.

Evaluation of leaf spot and curly top resistance in tetraploid lines
selected in US 401 for leaf spot resistance.

Seven tetraploid lines selected in US 401 for leaf spot resistance showed an average grade of leaf spot resistance in 2 years tests of 3.44

Table 1..... Evaluation of curly top and leaf spot resistance in tetra-
ploid lines selected for leaf spot resistance.

Code N		Leaf spot resistance			Curly top resistance			Index
1962	1963	1962	1963	Mean	1962	1963	Mean	$\frac{CT}{LS}$
S-62-1	S-63-23	3.0	4.0	3.50	7.0	7.0	7.0	2.0
S-62-2	S-63-24	3.0	4.0	3.50	5.0	4.0	4.5	1.29
S-62-3	S-63-25	2.5	4.0	3.25	3.0	4.0	3.5	0.92
S-62-4	S-63-14	3.0	3.5	3.25	7.0	6.0	6.5	2.00
S-62-5	S-63-16	3.5	3.8	3.65	5.0	5.0	5.00	1.37
S-62-6	S-63-15	3.3	4.0	3.65	5.5	5.0	5.25	1.44
S-62-7	S-63-29	2.8	3.8	3.33	7.0	7.0	7.00	2.10
Mean		3.0143	3.8714	3.4428	5.6429	5.4286	5.5357	
2n: US 401		3.0	4.0	3.50	8.5	7.8	8.15	2.33
4n: US 401		3.7	4.0	3.85	5.0	4.0	4.50	1.17
2n: US 35/3					2.0	2.0	2.00	
2n: Klein Wanz.		5.0	6.7	5.85	9.5	9.0	9.25	1.58
2n: US 201		1.5	2.2	1.85				
2n: S-23-m ²		1.0	1.2	1.10	9.5	9.0	9.25	8.41

(table 1). The average grade of severity of the diploid US 401 was 3.50, and of the tetraploid US 401, 3.85. The average grade of leaf spot resistance in 7 tetraploid lines was a little higher than in the original diploid and tetraploid population of US 401. During 2 years' testing, 5 of 7 lines were never evaluated lower in resistance to leaf spot than the diploid US 401. Two of 7 lines received the first year the same evaluation in resistance to leaf spot as the diploid US 401, and in the second year test, 1 line was graded 0.3 and another 0.5 of a point lower in resistance than the diploid US 401. None of the 7 lines in 2 years tests received lower grades for resistance to leaf spot than the original tetraploid population US 401.

These 7 lines were different in resistance to curly top, but their average resistance was higher than that of the diploid US 401 (table 1). Two of 7 lines were equal to the tetraploid US 401 in curly top resistance and five lines were lower in resistance. None of the tetraploid lines were selected for curly top resistance. In general, the relation of curly top and leaf spot resistance was better in these lines than in the diploid US 401. For instance, in the best line, S-62-3, the index $\frac{ct}{ls}$ did not reach even 1; i.e., in this line resistance to each disease appeared the same. In the tetraploid lines with the lowest value for curly top resistance, the index $\frac{ct}{ls}$ increased to 2.1. For the diploid US 401 this index was 2.33, and for the highly leaf spot resistant and completely susceptible to curly top line, S-23 m², it was 8.41 (table 1).

Evaluation of leaf spot and curly top resistance in tetraploid lines
selected in US 401 for curly top resistance.

Eight tetraploid lines selected in US 401 for curly top resistance were propagated twice without selection. The average 2-year evaluation in leaf spot resistance for these lines was 3.5625 (table 2), consequently the resistance to leaf spot in these lines was almost the same as in the diploid population US 401. Variation in leaf spot resistance was a little higher in these lines than in the tetraploid lines selected for leaf spot resistance. Two or 3 lines of this group had a lower evaluation than the original tetraploid population. But in general the changes in the grade of resistance to leaf spot were insignificant in spite of the high effectiveness of selection for curly top resistance.

It is possible that the high effectiveness of selection for curly top resistance was due to the high intensiveness of selection : only 0.5 to 1% of plants tested for curly top resistance produced seed for the following selection.

The average resistance to curly top in 8 lines was 4.1250, whereas in the diploid US 401 it was 8.15 and in the original tetraploid population, US 401, it was 4.50.

Table 2..... Evaluation of curly top and leaf spot resistance in tetraploid lines selected for curly top resistance.

Code N		Leaf spot resistance			Curly top resistance			Index
1962	1963	1962	1963	Mean	1962	1963	Mean	CT LS
S-62-22	S-63-1	3.0	3.7	3.35	4.0	3.0	3.5	1.04
S-62-23	S-63-2	3.5	3.7	3.60	4.0	3.0	3.5	0.97
S-62-24	S-63-3	3.7	4.2	3.95	5.0	4.0	4.5	1.14
S-62-25	S-63-22	3.8	4.0	3.90	5.0	4.0	4.5	1.15
S-62-26	S-63-4	3.3	3.7	3.50	3.0	3.0	3.0	0.86
S-62-27	S-63-5	2.5	3.7	3.10	5.0	5.0	5.0	1.61
S-62-28	S-63-6	3.2	4.2	3.70	4.0	5.0	4.5	1.22
S-62-29	S-63-7	2.8	4.0	3.40	5.0	4.0	4.5	1.32
Mean		3.2250	3.9000	3.5625	4.3750	3.875	4.1250	
2n: US 401		3.0	4.0	3.50	8.5	7.8	8.15	2.33
4n: US 401		3.7	4.0	3.85	5.0	4.0	4.50	1.17
2n: US 35/3					2.0	2.0	2.0	
2n: Klein Vanz.		5.0	6.7	5.85	9.5	9.0	9.25	1.58
2n: US 201		1.5	2.2	1.85				
2n: S-23-m ²		1.0	1.2	1.10	9.5	9.0	9.25	8.41

Improvement in curly top resistance and the very insignificant decline in leaf spot resistance resulted in a value of $\frac{ct}{ls}$ index for these lines which did not exceed 1.1 for almost 75% of the lines. In such a way, a good grade of resistance to curly top was combined with leaf spot resistance at the level peculiar to the leaf spot resistant parental variety.

Evaluation of leaf spot and curly top resistance in tetraploid lines selected for vigor and dry matter.

Tetraploid lines were selected for vigor and then for dry matter in Salt Lake City, Utah, under leaf spot and curly top-free conditions; therefore, these lines should be considered as checks for the 2 first mentioned selections.

The average evaluation of these 7 lines in leaf spot resistance was 3.5354; i.e., their grade of resistance did not differ from the diploid population US 401 for which the average grade of resistance was 3.50. Variation in leaf spot resistance was even lower in these lines than the variation in leaf spot resistance in the lines selected for curly top resistance (table 3).

The average evaluation of these lines in curly top resistance was still higher than of diploid US 401 and about the same as the average curly top resistance of the lines - progeny of plants selected for leaf spot resistance (tables 1 and 3).

At the same time the grade of curly top resistance was lower in these lines than in the lines selected for curly top resistance (tables 2 and 3).

Index $\frac{ct}{ls}$ for the lines of this group is better than for the diploid US 401 but worse than for the tetraploid original population US 401 (table 3).

Evaluation of leaf spot and curly top resistance in F_4 hybrids.

A tetraploid, monogerm, self-sterile line with a medium grade of resistance to curly top and susceptible to leaf spot was crossed to US 401. F_2 lines have been isolated in this hybrid under conditions of no infection with either diseases.

The average evaluation of leaf spot resistance in 6 such lines was 3.6333 (table 4); i.e., resistance to leaf spot almost equaled the resistance of the diploid US 401 or of tetraploid lines selected in US 401 for curly top resistance, vigor, or dry matter. One of these lines had grade of 3.25 in resistance to leaf spot.

Six F_4 hybrids exhibited a good grade of curly top resistance (2.9583) (table 4), while the grade of curly top resistance was 8.15 in the diploid US 401 and 4.50 in the tetraploid US 401.

Table 3.... Evaluation of curly top and leaf spot resistance in tetraploid lines selected for vigor and dry matter in a tetraploid population US 401.

Code N		Leaf spot resistance			Curly top resistance			Index
1962	1963	1962	1963	Mean	1962	1963	Mean	CT LS
S-62-8	S-63-26	3.0	4.5	3.75	6.0	6.0	6.00	1.60
S-62-9	S-63-28	3.5	4.5	4.00	5.5	5.0	5.25	1.31
S-62-10	S-63-27	3.0	4.2	3.60	5.0	5.0	5.00	1.39
S-62-11	S-63-17	2.3	3.5	2.90	5.0	4.0	4.50	1.55
S-62-12	S-63-18	3.2	4.0	3.60	6.0	4.0	5.00	1.39
S-62-13	S-63-19	3.3	4.0	3.65	5.0	5.0	5.00	1.37
S-62-14	S-63-20	2.5	4.0	3.25	7.0	7.0	7.00	2.15
Mean		2.9714	4.1000	3.5357	5.6429	5.1429	5.3929	
2n: US 401		3.00	4.00	3.50	8.5	7.8	8.15	2.33
4n: US 401		3.7	4.00	3.85	5.0	4.0	4.50	1.17
2n: US 35/3					2.0	2.0	2.00	
2n: Klein Vanz.		5.0	6.7	5.85	9.5	9.0	9.25	1.58
2n: US 201		1.5	2.2	1.85				
2n: S-23- μ^2		1.0	1.2	1.10	9.5	9.00	9.25	8.41

Table 4... Evaluation of curly top and leaf spot resistance in tetraploid F_4 hybrids derived from crosses of tetraploid monogerm self-sterile strain to tetraploid US 401.

Code N		Leaf spot resistance			Curly top resistance			Index
1962	1963	1962	1963	Mean	1962	1963	Mean	$\frac{CT}{LS}$
S-62-15	S-63-8	3.2	3.3	3.25	2.5	3.5	3.00	0.92
S-62-16	S-63-9	3.3	4.0	3.65	2.0	2.0	2.00	0.55
S-62-17	S-63-11	3.8	4.0	3.90	2.5	3.0	2.75	0.71
S-62-18	S-63-10	3.5	4.0	3.75	4.0	4.0	4.00	1.07
S-62-19	S-63-12	3.3	4.0	3.65	3.0	3.0	3.00	0.82
S-62-20	S-63-13	3.2	4.0	3.60	3.0	3.0	3.00	0.83
Mean		3.3833	3.8833	3.6333	2.8333	3.0833	2.9583	
2n: US 401		3.0	4.0	3.50	8.5	7.8	8.15	2.33
4n: US 401		3.7	4.0	3.85	5.0	4.0	4.50	1.17
2n: US 35/3					2.0	2.0	2.00	
2n: Klein Vanz.		5.0	6.7	5.85	9.5	9.0	9.25	1.58
2n: US 201		1.5	2.2	1.85				
2n: S-23-m ²		1.0	1.2	1.10	9.5	9.0	9.25	8.41

One of the hybrid lines (S-62-15) showed the grade of resistance to curly top of 3.0 and a grade of resistance to leaf spot of 3.25, which gave a value of 0.92 for the $\frac{ct}{ls}$ index. In the other line (S-62-16) the grade of resistance to leaf spot was 3.65 and to curly top 2.0, and its $\frac{ct}{ls}$ index decreased to 0.55.

Thus, hybridization of tetraploid lines, without selection for curly top or leaf spot resistance, produced some tetraploid lines in which the resistance to curly top and to leaf spot was maintained on the same, or even on the higher level, than in the original diploid parental varieties. Each of parental varieties was resistant to only one disease.

Discussion and conclusion

1. Tetraploid lines in self-sterile tetraploid population US 401 showed in many experiments higher resistance to curly top than the original diploid variety US 401. At the same time, the majority of these tetraploid lines were approximately equal or better in leaf spot resistance than the diploid variety US 401.
2. A study of curly top resistance at Thatcher (Utah) and leaf spot resistance at Fort Collins (Colorado) during 1962 and 1963, in 29 tetraploid lines derived after selection for curly top and leaf spot resistance, vigor, and dry matter, showed that selection for curly top and for leaf spot resistance is effective in tetraploid sugarbeet lines. Selection for resistance to either disease (leaf spot or curly top) fixed the more resistant lines and excluded the lines low in resistance. (Tables 5 and 6.)
3. Selection for one disease affected only slightly the average evaluation of lines for resistance to the other disease. Selection improved the individual lines in resistance to disease for which they were selected. At the same time, in some of these lines the resistance to another disease was not reduced. This is well demonstrated in the line S-62-3 selected for curly top resistance and in the line S-62-22 selected for leaf spot resistance.
4. The highest evaluations in curly top and leaf spot resistance were obtained when the lines were selected for curly top resistance. Such selection led to considerable improvement of curly top resistance with insignificant changes in leaf spot resistance. Higher effectiveness of selection for curly top than for leaf spot resistance was obviously due to higher intensiveness of selection for curly top than for leaf spot resistance.
5. However, the best combination of resistance to both diseases was obtained in some hybrid lines derived from crosses of curly top and leaf spot resistant tetraploid parents, and also even when the parental strains have been propagated under conditions which excluded the possibility of improvement in resistance.

6. In such a way, the results obtained indicate that the method of tetraploid selection, based on the selection in the varietal populations or in hybrid progenies, may be considered as one of methods which leads to improvement of different types of resistance (curly top, leaf spot) and as a method which makes possible the combining on a higher level of resistance to 2 diseases in the same tetraploid population.

7. A method of combining 2 desirable genomes from different autotetraploids in one tetraploid population is an important breeding method for association of polygenic traits, if the desirable grade of both traits is manifested in the F_1 generation.

Table 5 ... Mean curly top and leaf spot resistance in 1962 and 1963 in tetraploid lines selected for curly top resistance, leaf spot resistance, vigor, or dry matter in the tetraploid population US 401 and in F_4 hybrids

Tetraploid lines	Number of lines	Leaf spot resistance			Curly top resistance		
		1962	1963	Mean	1962	1963	Mean
Selected for vigor and dry matter	7	2.9714	4.1000	3.5357	5.6429	5.1429	5.3929
Selected for leaf spot resistance	7	3.0143	3.8714	3.4428	5.6429	5.4286	5.5357
Selected for curly top resistance	8	3.2250	3.9000	3.5625	4.3750	3.8750	4.1250
F_4 tetraploid hybrids	6	3.3833	3.8833	3.6333	2.8333	3.0833	2.9583
Diploid population US 401	1	3.0000	4.0000	3.5000	8.5	7.8	8.15
Tetraploid population US 401	1	3.7000	4.0000	3.8500	5.0	4.0	4.50

Table 6 Mean curly top and leaf spot resistance for 2 years in 29 tetraploid lines selected for curly top resistance, leaf spot resistance, vigor, or dry matter in the tetraploid population US 401 and in F₄ hybrids.

Tetraploid lines	Leaf spot resistance		Curly top resistance	
	Mean evaluation of lines	Range of variation between lines	Mean evaluation of lines	Range of variation between lines
Selected for leaf spot resistance	3.44	3.25 - 3.65	5.54	3.5 - 7.0
Selected for curly top resistance	3.56	3.10 - 3.95	4.13	3.0 - 5.0
Selected for vigor and dry matter	3.54	2.90 - 4.00	5.39	4.5 - 7.0
F ₄ tetraploid hybrids	3.63	3.25 - 3.90	2.96	2.0 - 4.0
Diploid population US 401	3.50	-	8.15	-

PRODUCTION OF TETRAPLOID STRAINS

by Helen Savitsky

1/ One monogerm curly top resistant inbred and 2 nematode resistant strains received from Mr. Charles Price were treated by colchicine in 1961. C_1 seed, obtained from intercrosses of selected C_0 tetraploid plants during the summer of 1962, were planted in greenhouse. Young C_1 plants obtained from these strains were checked for the number of chromosomes and exposed to thermal induction. In the spring, the C_1 tetraploid plants selected were planted in isolations and new tetraploid strains were produced.

2/ Three monogerm inbred lines and 3 male-sterile equivalents for them were treated with colchicine in 1962. The affected seedlings were transplanted to the field in the spring of 1963, and tetraploid C_0 plants were selected in these strains. C_1 seed were obtained from selfing of tetraploid plants selected in the inbred lines. Because the self-fertile plants did not develop a sufficient amount of pollen under the low temperatures of spring and early summer, the selected male-sterile plants could not be pollinated by the pollen of tetraploid plants from the corresponding inbreds. The tetraploid male-sterile plants selected were maintained until the next season. C_1 seed harvested from selfed tetraploid plants were planted in greenhouse for determination of chromosome numbers and selection of tetraploid plants in 1964.

3/ Some new monogerm and multigerm lines were treated by colchicine in the fall of 1963.

Study of the influence of colchicine treatment on different materials is being continued.

INTERSPECIFIC HYBRIDIZATION

by Helen Savitsky.

To maintain the basic pool of interspecific F_1 hybrids between Beta vulgaris and species of the section Patellares, new crosses are continuously made and new hybrids produced; the F_1 hybrids previously produced are maintained and propagated as far as possible.

Production of seed from F_1 hybrids is continued by growing several hundred plants for pollination of F_1 hybrids.

Cytogenetic study, growing of the next hybrid generation (b_1), and test of b_1 hybrids for resistance to sugarbeet nematode (Heterodera schachtii) are being continued.

Meiosis in triploid(sesquidiploid) and in allotetraploid hybrids between

Beta vulgaris and species of the section Patellares.

Meiosis in triploid hybrids. Triploid F_1 hybrids ($4n$ B. vulgaris \times $2n$ B. procumbens) contained 2 genomes of B. vulgaris (18 chromosomes) and 1 genome of B. procumbens (9 chromosomes). As in diploid hybrids between B. vulgaris and B. webbiana or B. procumbens, so in triploid and in allotetraploid hybrids association of chromosomes belonging to different species (allosyndetic association) was observed. In triploid hybrids at diakinesis, besides bivalents, trivalents and quadrivalents were formed. Bivalents were present in all pollen mother cells (PMC). Their number varied from 5 to 11. All PMC contained 1 to 3 trivalents or quadrivalent associations. Quadrivalents were observed in smaller numbers (1, 2 per PMC). Pentavalents were seldom formed.

It may be assumed that in triploid hybrids with 18. B. vulgaris and 9 B. procumbens chromosomes, a greater affinity of B. vulgaris chromosomes will lead to autosyndetic pairing, but some bivalents may be formed by allosyndesis as in the corresponding diploid hybrids.

The large number of associations - 10, 11, 12 - observed in these hybrids is due to the associations formed by B. vulgaris and B. procumbens chromosomes, since the number of associations formed exclusively by autosyndesis of B. vulgaris chromosomes cannot exceed 9. Presence of a large number of associations 11, 12 (for instance: 12 assoc. : $10_{11} + 2_{111} + 1_1$) indicates the possibility of occurrence of translocations which enable association between nonhomologous chromosomes of different species. Formation of these associations is possible on the basis of breakage and interchanges between chromosomes of different species. The heterobivalents with terminal deficiencies and with additional segments were observed in the pollen mother cells.

Trivalents are presented in the shape of rods, chains, loops, Y-type associations and open or closed rings (fig. 1). All types of trivalents with exception of closed rings, originated from association of 2 homologous chromosomes of B. vulgaris with a homologous segment of a B. procumbens chromosome, or by association of one normal B. vulgaris chromosome with translocated B. vulgaris and B. procumbens chromosomes.

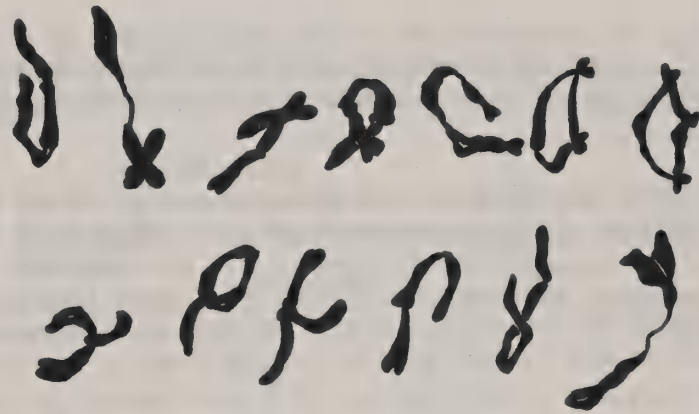


Fig. 1. Triploid hybrids - $4n$ B.vulgaris x $2n$ B.procumbens

Trivalent associations at diakinesis

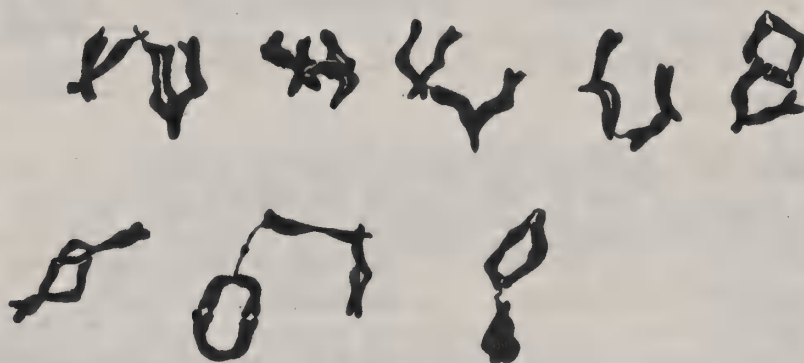


Fig.2. Allotetraploid hybrids - $4n$ B.vulgaris x $4n$ B.patellaris

Tetravalent associations at diakinesis

A closed ring of three may originate only if one of 3 chromosomes involved in the association is segmentally changed and its both ends are identical. It may be an iso-chromosome derived from B. procumbens telocentric chromosome.

indicated that

Observations in the triploid hybrids/closed rings of 3 originated as a consequence of reciprocal translocation involving only 1 chromatid of B. vulgaris and 1 chromatid of B. procumbens chromosomes; the other arm of this B. procumbens chromosome carries a segment homologous to B. vulgaris chromosome.

The ring is formed by association of 2 homologous B. vulgaris chromosomes one of which is connected by a second chiasma with a homologous segment in the left arm of B. procumbens chromosome. The chromatid translocated into the B. procumbens chromosome forms a chiasma with the normal chromatid of B. vulgaris chromosome and this chiasma closes the ring.

Such a closed ring of 3 sometimes forms a quadrivalent association when the normal chromatid of B. procumbens chromosome associate with the homologous segment in another pair of B. vulgaris chromosome.

In such a way, every trivalent association involves one entire B. procumbens chromosome or a segment of B. procumbens chromosome.

Quadrivalents were presented in the shape of rods, chains, figures of eights, and open or closed rings.

The quadrivalent association may arise from association of 2 bivalents associated by a chiasma at the homologous segments. Such a quadrivalent may involve 1 bivalent formed by 2 chromosomes of B. vulgaris and a second bivalent formed by 1 chromosome of B. vulgaris and 1 chromosome of B. procumbens, or both bivalents may consist of 1 B. vulgaris and 1 B. procumbens chromosome.

Quadrivalent associations may arise also as a result of translocations involving B. vulgaris and B. procumbens chromosomes. In such a quadrivalent one arm of the normal B. vulgaris chromosome associates with the translocated B. vulgaris chromosome, and another arm with the translocated B. procumbens chromosome. The normal arm of the B. procumbens chromosome associates with a homologous segment in the B. vulgaris chromosome of another pair. This kind of association may produce quadrivalents of different configuration but not closed rings. Formation of a closed ring of 4 in a triploid hybrid requires 2 translocations - one in each arm of the B. procumbens chromosome.

A B. procumbens chromosome which carries the double translocation, forms a terminal chiasma with the normal B. vulgaris chromosome of the first translocated pair, and the other arm associates with the normal

B. vulgaris chromosome from the second translocated pair. These 2 B. vulgaris chromosomes associate with the translocated B. vulgaris chromosome of the first pair.

In this way, a quadrivalent association will always involve 1 or 2 chromosomes of B. procumbens or 1 or 2 segments of B. procumbens chromosomes.

At the first anaphase separation and the movement of chromosomes in the spindle was not simultaneous, but all or almost all chromosomes, reached the poles.

Interkinetic nuclei contained from 11 to 16 chromosomes.

Meiosis in allotetraploid hybrids (4n B. vulgaris x B. patellaris).

The F_1 allotetraploid hybrids carry 2 genomes of B. vulgaris and 2 genomes of B. patellaris (18 chromosomes of each species).

In meiosis of allotetraploid hybrids many multivalent associations were formed along with bivalents.

Quadrivalents, as shown ^{by} their configuration, were often formed by association of 2 bivalents at the homologous segments (fig. 2).

Hexavalents arose from association of 3 bivalents.

Octavalents were formed by association of 2 quadrivalents.

The higher valency associations of 10 or 14 chromosomes were also observed.

The majority of associations were bivalents. They arose mainly from autosyndetic association formed by the chromosomes belonging to the same species. Almost all PMC contained quadrivalents, and in many cells, hexavalents were observed. Every multivalent association, and some bivalents, included chromosomes of B. patellaris.

Vulgares-Patellares hybrids are segmental hybrids. They carry some homeologous chromosomes which enable the association of B. vulgaris chromosomes with the chromosomes of the species of the section Patellares. The allotetraploid hybrids did not form 9 B. vulgaris and 9 B. patellaris bivalents, typical for the true amphidiploid hybrids. The type of chromosome association in Vulgares-Patellares hybrids is similar to that found in several other segmental hybrids such as Primula Kewensis, Crepis capillaris-tectorum, Allium cepa-fistulosum, Nicotiana glauca, and others.

Pairing in Vulgares-Patellares hybrids is auto- and allosyndetic. Besides bivalents, multivalent associations involving chromosomes of both parental species are formed.

First division is more regular in allotetraploid than in triploid hybrids and fewer laggards were observed in the first anaphase. Almost all chromosomes moved to the respective poles.

The interkinetic nuclei contained from 15 to 20 chromosomes. In the majority of them 17, 18 or 19 chromosomes were observed.

Thus, chromosomes of both parental species were transmitted in triploid and in allotetraploid hybrids to the interkinetic nuclei, and, after the second division, to the nuclei of tetrads. All gametes of triploid and allotetraploid hybrids contained in addition to B. vulgaris chromosomes many chromosomes of species of the section Patellares.

The outline of meiosis indicates the possibility of transmission of genes from Patellares species into species of B. vulgaris.

First backcross hybrids showed striking resemblance to the backcross parent B. vulgaris. Analysis of chromosome numbers showed that the progeny of triploid hybrids consisted mainly of plants with 18 chromosomes. Some plants were trisome (19 chromosomes), double trisome, or tetrasome with 20 chromosomes. Chromosome number in progeny of allotetraploid hybrids was 36, or approached 36. It is obvious that only those gametes were viable which carried either a haploid or a diploid set of B. vulgaris chromosomes or a complete set of B. vulgaris chromosomes with an addition of 1 or 2 chromosomes--in some cases, alien chromosomes.

Fast recovery to the B. vulgaris type is due to the elimination of gametes and zygotes with unbalanced chromosome numbers or unbalanced composition of chromosome sets caused probably by duplications or deficiencies resulting from the type of separation of the multivalents.

In spite of the general resemblance to the B. vulgaris type, the hybrids of the first backcross generation manifested several characters of wild species. Characters of wild species are transmitted to the first backcross generation a/ as a substitution - by segmental interchanges due to translocations and crossingover, which results in incorporation of segments of chromosomes of wild species into the chromosomes of B. vulgaris, and b/ in some cases, as an addition by the supplement of single chromosomes from wild species to the set of B. vulgaris chromosomes.

Test for resistance to sugarbeet nematode (Heterodera schachtii) in

Vulgares-Patellares hybrids.

by Helen Savitsky and Charles Price.

1. Test of the first backcross hybrid generation. Seed of the first backcross generation were obtained by H. Savitsky. F₁ hybrids between B. vulgaris and species of the section Patellares were pollinated by sugarbeet plants to produce first backcross hybrids.

Four hundred plants of the first backcross progeny were tested for nematode resistance in 1963. Seeds were planted in the greenhouse. Germination of bl seed was about 10%. Seedlings in the 2-leaf stage were transplanted by H. Savitsky in nematode-infested soil prepared by Charles Price. Sixty days after infestation the hybrid plants were examined by both investigators for presence of female nematodes on the roots. Hybrids with heavy and medium infestation were discarded. Only the plants with few female nematodes (0 to 10) were selected. Some hybrid plants free of nematodes were found for the first time.

To gain more confidence in selections, plants with few nematodes on the roots were transplanted again in nematode-infested soil for a repeated check. A method of threefold testing used in 1962 showed some disadvantage, because several hybrid plants did not survive 3 transplantings after cutting the leaves and root system at each transplanting. Therefore, the repeated tests were used in 1963 in accordance with the vigor of hybrid plants. The most vigorous plants were tested 3 times, those lower in vigor were tested twice, and the weakest plants were tested only once.

Of 400 first backcross hybrids tested, 33 plants were selected which had only a few nematodes on the roots. These are growing in the greenhouse and will be exposed to thermal induction for seed production in 1964.

2. Test of F₁ hybrids for nematode resistance.

Seed of 2 parental species, tetraploid Beta vulgaris (sugarbeet) susceptible to nematode and tetraploid B. patellaris resistant to nematode, together with F₁ hybrid seed obtained from crosses of these species, were planted in soil in the greenhouse. Viable matings were selected in which F₁ hybrids grew on their own roots.

Ten seedlings of each parental species and 10 seedlings of F₁ hybrids were transplanted in the 2-leaf stage into cyst-infested soil to test for nematode resistance. After 60 days of growth the plants were examined for the presence of female nematodes on the roots.

The 10 sugarbeet plants were heavily infested with nematodes. Nine of 10 B. patellaris plants were free of nematodes and 1 plant had 2 females on the roots. The F_1 hybrids had well developed root systems. Of 10 F_1 hybrid plants 8 were free of nematodes, 1 had 1 comparatively well developed female, and on 1 plant 2 females were found.

The plants examined fell into 2 groups : a highly susceptible group which contained sugarbeets, and a resistant group which included B. patellaris and F_1 hybrids. The data obtained were calculated by using the chi-square method. The value of chi-square was 0.3922. Tabulated value at the 5% level for d.f. = 1 is $\chi^2_{0.05} = 3.841$ and at 1% level $\chi^2_{0.01} = 6.63$. The tabulated value of the chi-square is much larger than the calculated value, which indicates that the difference in resistance between B. patellaris and F_1 hybrids is not significant.

Resistance to nematode (Heterodera schachtii) is a dominant character. The tetraploid F_1 hybrids (B. vulgaris x B. patellaris) did not differ in the grade of resistance from the resistant parent, B. patellaris.

Preliminary tests of related interspecific hybrids for resistance to Heterodera schachtii are given in Sugarbeet Research, 1962 Report, pp. 247-248.

P A R T VIII

BREEDING FOR NEMATODE RESISTANCE
and
SCREENING TESTS IN FIELD AND GREENHOUSE

Foundation Project 13

Charles Price

PROGRESS REPORT TO THE SUGARBEET DEVELOPMENT FOUNDATION ON BREEDING
SUGARBEETS FOR RESISTANCE TO THE CYST NEMATODE HETERODERA SCHACHTII
AND OTHER STUDIES OF NEMATODES

(Foundation Project 13)

Charles Price

Breeding sugarbeets for resistance to Heterodera schachtii has taken on much greater significance than formerly, since it has been determined that the cyst nematode plays an important part in the damage caused by other diseases of sugarbeets. Root rotting fungi, for example, cause more damage to nematode-susceptible sugarbeets when nematodes are also present in the soil than when they are absent. Experimental results are reported elsewhere in this report of the damage to variety US 41 by nematodes alone and in combination with root rotting fungi. In breeding sugarbeets for resistance to H. schachtii at Salinas, California, it has been observed in greenhouse screening tests for possible resistance to this nematode that Rhizoctonia causes less damage to sugarbeets when other soil organisms are present with Rhizoctonia than with a pure culture isolate of Rhizoctonia taken from the same soil. The reason for this phenomenon is not understood. There is need to separate pathogenic fungi found in the soils in which sugarbeets are grown and to evaluate the separate pathogenic capability of the fungi alone and in combination with Heterodera schachtii. Studies along these lines are in progress in cooperation with Dr. C. L. Schneider of Crops Research Laboratory, Logan, Utah.

New lines of sugarbeets developed for tolerance to nematode (Figure 1) and lines tested in previous years were included in a field test in 1963. The field test (Figure 2) was located at the U. S. Agricultural Research Station at Salinas, California.

Testing Lines of Sugarbeets for Resistance to Heterodera Schachtii.

Soil of the test field on the Station grounds has been inoculated with nematode cysts and root-rotting fungi. This was achieved by means of distributing soil containing a high population of nematode cysts uniformly over the field and planting sugarbeets to build up the population of nematodes. In addition to nematode cysts, root-rotting fungi were added to the soil.

Lines of sugarbeets selected for resistance to nematodes and root rot were planted in randomized replicated plots, using US 41 and US 75 as checks. The damage from nematode and root rot was severe and yields were affected adversely. Field-grown beets were selected from the segregating population, and these selections are being thermally induced for seed increase and hybridization. Yield data are presented in Table 1. It is apparent from Table 1 that there is a wide difference in yield among the

lines. Many of the lines are significantly higher than the checks US 41 and US 75. US 41 has been used consistently in tests for resistance to nematode, and it has been found that, while this variety is susceptible to nematode, it is not the most susceptible commercial variety. All lines in the 1963 test were superior in yield of roots to US 41 and US 75. US 75 was lower in yield in the 1962 test than US 41 and appreciably better than US 41 in the 1963 test. US 75, because of its adaptability in the Salinas Valley, was used extensively in commercial planting before hybrids were developed.

The selections for nematode resistance would undoubtedly reduce losses as compared with open-pollinated varieties. Resistance must be incorporated into hybrid varieties to gain the most from nematode resistant lines in developing commercial varieties. Most promising lines for resistance to nematode are multigerms. Some monogermers have been screened for resistance to nematodes, but more work is necessary to develop nematode resistant monogermers. The value of monogermers in commercial varieties has been demonstrated and, eventually, all sugarbeet seed planted commercially will be monogerm, because of its advantages over multigerm. Some monogerm material has been screened for resistance to nematode, but little improvement has as yet been made. Work is being continued in cooperation with Helen Savitsky on hybridization between Beta vulgaris and Beta patellaris. (See page 297.)

BOLTING TEST, SALINAS, CALIFORNIA, 1963

It is important that the plant breeder knows the bolting tendencies of lines of sugarbeets which he uses in his hybridization program. Knowledge of bolting tendencies of breeding material is especially important in California where sugarbeets are planted in fall and winter at a time when temperatures are favorable for thermal induction. Easy bolting sugarbeets are not desirable for fall and winter planting in California because of reduced production, troublesome seed stalks at harvest, and later volunteer beet problems. A test was designed in which some breeding lines of sugarbeets developed in connection with breeding for nematode resistance were included. The purpose of the test was to determine the amounts of bolting in a winter planting at Salinas, California.

Two commercial varieties with wide differences in bolting tendencies were included in the test, because these varieties are used in nematode tests to measure the degree of resistance in nematode resistant lines of sugarbeets. US 41 is an easy bolting variety, and US 75 is bolting resistant. US 75 has been used widely in the Salinas Valley for winter plantings because of its resistance to bolting. Plots in the test consisted of single-row plots 25 feet in length with three replications for each line in the test. The results are presented in Table 2. In this table are presented the average bolting percents of the three replications for each variety. Most of the lines tested are shown to be easy bolters. Line 133 is significantly lower in bolting percentage than US 75. Lines 060-3, 861-15, and 057-10 are about equal to US 75, and all other lines bolted much more than US 75 and approximately equal to US 41.

AGRONOMIC EVALUATION TEST, 1963

Conducted: By Charles Price

Location: Salinas, California

Date of Planting: May 6 and 7, 1963

Experimental Design: Randomized Block

Size of Plot: 1 row 25 feet long

Date of Harvest: October 15, 1963

Stand Count: At harvest

Field History: Vetch cover crop during winter; sugarbeets 1 year with nematode cysts and root rotting fungi added to the soil.

Fertilization: 100 pounds of P_2O_5 per acre applied to cover crop;
100 pounds of nitrogen per acre as a side dressing after thinning.

Virus Yellows Exposure: Natural, but severe

Root Rot Exposure: Severe

Nematode Exposure: Severe

Other Diseases: Western yellows and mosaic

Table 1. Sugarbeet Nematode Resistance Evaluation Test,
Salinas, California 1963.

<u>Line or Variety</u> <u>Breeder's No.</u>	<u>Acre Yield</u> <u>Tons</u>	<u>Increase Acre</u> <u>Yield Over US 41</u> <u>Tons</u>	<u>Increase Acre</u> <u>Yield Over US 75</u> <u>Tons</u>
102-9	24.31	14.72	9.15
102-23	24.23	14.64	9.07
863	24.23	14.64	9.07
028	23.79	14.20	8.63
157-F3	22.57	12.98	7.41
856-1	22.40	12.81	7.24
SL 054-2	22.40	12.81	7.24
SL 060-3	22.05	12.46	6.89
133-3A	21.96	12.37	6.80
260	21.79	12.20	6.63
162-15	21.44	11.85	6.28
257-5	21.18	11.59	6.02
294	21.18	11.59	6.02
134-H8	21.09	11.50	5.93
SL 054-1	21.01	11.42	5.85
C 057-15	20.74	11.15	5.58
861-25	20.57	10.98	5.41
257-10	20.31	10.72	5.15
033-1	20.22	10.63	5.06
C 076-6	20.22	10.63	5.06
101-13	20.22	10.63	5.06
90-207	19.87	10.28	4.71
SL 254-1	19.52	9.93	4.36

(continued)

Table 1 - Continued.

<u>Line or Variety</u> <u>Breeder's No.</u>	<u>Acre Yield</u> <u>Tons</u>	<u>Increase Acre</u> <u>Yield Over US 41</u> <u>Tons</u>	<u>Increase Acre</u> <u>Yield Over US 75</u> <u>Tons</u>
050-6	19.26	9.67	4.10
102-5	18.98	9.39	3.82
B 075	18.83	9.24	3.67
150-1	18.56	8.97	3.40
128B1	18.56	8.97	3.40
801-7	18.56	8.97	3.40
156-22	18.04	8.45	2.88
1089 G	17.78	8.19	2.62
134	17.61	8.02	2.45
338	17.43	7.84	2.27
80-75	17.43	7.84	2.27
862	17.35	7.76	2.19
192	17.13	7.54	1.97
171-13	16.73	7.14	1.57
B 076	16.56	6.97	1.40
899-11	16.56	6.97	1.40
062-11	16.38	6.79	1.22
U 074	16.38	6.79	1.22
219	16.38	6.79	1.22
0317	16.21	6.62	1.05
339	16.21	6.62	1.05
US 75	15.16	5.57	--
US 41	9.59	--	-5.57

L. S. D. 5% 4.81 Tons Acre

L. S. D. 1% 6.36 Tons Acre

Table 2. BOLTING TEST, SALINAS, CALIFORNIA 1963

<u>Line or Variety</u> <u>Breeder's No.</u>	<u>Av.</u> <u>Stand</u>	<u>Bolter Counts Date</u>						<u>Total</u> <u>Percent</u>
		<u>5/13</u> <u>%</u>	<u>5/28</u> <u>%</u>	<u>6/12</u> <u>%</u>	<u>7/9</u> <u>%</u>	<u>7/30</u> <u>%</u>	<u>8/21</u> <u>%</u>	
133	37	0	0	0	0	.9	7.1	8
033-1	35	25.8	27.4	15.2	24.8	4.8	1.9	100
SL 060-3	35	0	0	3.8	13.5	9.9	5.4	33
856-1	35	0	12.3	7.6	33.3	7.7	6.7	68
150-1	36	0	11.9	18.1	32.5	15.9	7.4	86
C 057-15	35	1.9	4.6	13.8	29.8	24.7	3.9	79
SL 054-1	36	0	8.3	9.3	34.3	9.3	5.6	67
060	36	0	6.2	14.1	27.7	17.8	4.6	70
159-8	36	0	4.5	13.9	31.5	15.7	6.4	72
861-15	36	0	0	1.0	5.5	14.7	9.3	30
162-15	36	1.0	44.9	26.1	11.4	6.5	1.0	91
861-25	37	0	14.1	21.5	27.0	10.3	2.8	76
B 076	38	0	10.6	17.7	36.3	17.7	2.7	85
0317	34	9.3	29.7	8.7	28.1	10.5	4.9	91
802-5	36	0	3.5	6.9	33.7	14.6	7.5	66
134-H8	33	0	2.9	2.0	34.3	22.7	4.1	67
133-3A	32	2.4	24.4	24.2	24.3	4.2	3.2	83
028	34	12.8	34.8	17.1	14.0	5.9	1.0	86
U074	34	6.8	24.7	15.9	22.3	7.0	3.9	81
134-30B	38	0	23.8	15.0	16.3	7.1	5.4	68
057-10	36	0	1.0	1.8	12.1	7.4	5.5	28
050-6	33	1.0	14.1	31.0	28.5	8.1	1.9	85
894-6	37	0	29.1	30.0	21.8	9.1	2.7	93
028	31	48.0	29.2	9.0	8.0	6.2	0	100
US 75	33	.7	2.1	10.2	2.0	4.4	4.7	24
US 41	37	11.6	24.6	12.4	21.2	12.4	4.7	87

Relation Between Heterodera Schachtii and Root Rot of Sugarbeets

Introduction

Damping-off is the principal cause of poor stands of sugarbeets. The suddenness of damping-off attack is often impressive, inasmuch as one day the seedlings look good, and the next day they are dying in large patches in the field. Damping-off fungi are almost universally in the soil, and early-planted sugarbeets are subject to attack, especially in wet soil. Pre-emergence damping-off is perhaps the most serious aspect of the disease, because seedlings are attacked before they reach the surface of the soil and nothing can be done to remedy the situation except to replant.

In commercial sugarbeet production post-emergence rotting of sugar beets also causes serious losses, because rotting sometimes continues throughout the entire period of growth resulting in low quality or final death of the plant. It has been observed by the author that the incidence of root rot is greater and the disease more severe in fields of sugarbeets in which nematodes are also present in the soil than when nematodes are absent. It is concluded, therefore, that the punctures made in the root tissue of sugarbeets by larvae of Heterodera schachtii afford a means for entrance of soilborne pathogens, which results in severe damage to sugar beets by combination of nematode and root rot.

In connection with breeding sugarbeets for resistance to Heterodera schachtii, it has been observed in greenhouse screening tests at Salinas, California, that damage to sugarbeets from root-rotting fungi is greatly increased if grown in soil infested with nematodes. It was, therefore, important to determine the amount of reduction in yield by nematodes alone and in combination with root-rotting fungi. This paper reports tests conducted under controlled conditions on the effect on yield of sugarbeets grown in (1) soil with nematodes (2) soil with pathogenic fungi and (3) soil with both nematode and fungi. The predominant fungus causing root rot was believed to be Rhizoctonia solani, because this fungus was later isolated from the soil used in this test.

Plan and Procedure

The variety US 41 was used in all tests. Comparisons in yields were made on the basis of weight of roots after petioles and leaf blades were removed. Seeds were planted in sterile sand and the seedlings were transplanted to the soil in three-gallon crocks with one seedling per crock.

There were three replicated plots of 10 crocks each for each of the four treatments in the test, or a total of 30 beets per treatment, and each root was weighed separately. Treatment 1 consisted of adding nematode cysts to soil which had been sterilized to insure destruction of root-rotting fungi. Treatment 2 consisted of soil known to contain root-rotting fungi added to the sterilized soil which had no nematodes present.

Treatment 3 consisted of soil in which both nematodes and root-rotting fungi were added to the sterilized soil. Treatment 4 (control) consisted of sterilized soil with no nematodes or root-rotting fungi added.

Results

Results given in Table 3 show comparisons between sugarbeets grown in nematode-free soil and soil infested with H. schachtii and root-rotting fungi. The percent reduction in weight of beets was 12.74 for those grown in soil with root-rotting fungi alone, 26.9 in soil with H. schachtii alone, and 45.8 in soil in which both nematodes and root-rotting fungi were added.

Summary

In this test it is evident that reduction in weight of the sugarbeet roots was lowest in the beets grown in soil with root-rotting fungi alone, next lowest with nematodes alone, and highest with both nematodes and root-rotting fungi present. Sugarbeets exposed to both nematodes and root-rotting fungi suffered more damage than the sum of losses due to nematodes alone and root rot alone. The beets were apparently weakened by nematodes, and root rot was then more severe when the beets were under stress of the effect of nematodes.

Table 3. Relation Between Heterodera Schachtii and Root Rot of Sugarbeets

<u>Treatment</u> Sugarbeets Grown:	<u>Av. Wt.</u> <u>of Beets</u> <u>Grams</u>	<u>Difference Between</u> <u>Control & Disease</u> <u>Grams</u>	<u>Loss Due</u> <u>to Disease</u> <u>Percent</u>
In soil with root-rotting fungi alone	586.0	85.6	12.74
In soil infested with <u>H. schachtii</u> alone	491.0	180.6	26.9
In soil with both <u>H. schachtii</u> and root-rotting fungi	364.0	307.6	45.8
No disease (control)	671.6	---	---

CORRELATION OF ROOT TO TOP OF NEMATODE-RESISTANT AND SUSCEPTIBLE SUGARBEETS GROWING IN NEMATODE-FREE AND INFESTED SOIL, SALINAS, CALIFORNIA

Variation in size of roots and tops of sugarbeets within a variety is readily observed. Sugarbeets growing in nematode-infested soil, however, react differently than those growing in nematode-free soil. Susceptibility to nematode damage in sugarbeets is usually observed as reduction in weight of roots. In commercial fields of sugarbeets stands are reduced by nematodes and, therefore, some beets have more space than others in which to grow. In nematode-free soil beets given more space in the row usually are larger in size than beets in a dense stand. In nematode-infested soil, however, sugarbeets rarely are larger, even if given more space. Under stress of nematodes they are unable to take advantage of the extra space allotment. Resistance to damage from nematodes is judged primarily on the basis of reduction in root weight. In breeding for resistance to nematodes the principal aim is to develop selections which show little differences in weight of roots between beets grown in nematode-infested and nematode-free soil. It would be of great value to the plant breeder to be able to judge the relative resistance of sugarbeet selections by some criterion other than root weight; for example, top vigor. It has been observed that some nematode resistant lines of sugarbeets have more top vigor than susceptible varieties when grown under conditions of heavy exposure to nematodes. To determine the reduction by nematodes in weight of roots and the relation of tops to roots in susceptible and resistant lines, an experiment was designed in which resistant and susceptible sugarbeets were compared in nematode-free and nematode-infested soil. Three seeds were planted in three-gallon crocks and all but one seedling was removed from each crock. Individual beets grown in separate crocks containing nematode-infested and nematode-free soil were randomized in nine replications, each replication consisting of three beets. Each beet was harvested separately and the weight of each root and top was weighed and recorded. US 41, a good commercial variety, which has been planted extensively, was used as check.

Referring to Table 4, it is seen that line 857-3 is susceptible to the effects of nematode infestation. In clean soil the mean top weight was 657.2 grams and the mean root weight was 1546.1 grams. The beets grown in infested soil had a mean top weight of 467.2 grams, while the mean root weight was 1101.1 grams. The reduction in root weight of 445.0 grams and in top weight of 190.0 grams was significant (5% LSD=178.1 grams). The check variety, US 41, had a mean top weight of 691.0 grams and a mean root weight of 1278.1 grams in clean soil. In infested soil the mean top weight was 459.7 grams, while the mean root weight was 880.3 grams. The reduction of the tops and roots in infested soil as compared with non-infested soil was significant (5% LSD=187.1 grams). The root loss of 397.8 grams and the top loss of 231.3 grams was due to the influence of nematodes. The premise is valid as regards susceptibility--that is, the root weight and top weight are both reduced due to infestation with nematodes. Line 801-7 similarly gave a susceptible reaction to nematodes.

Table 4. Mean Yield of Tops and Roots of Sugarbeets grown
in Nematode-free and Nematode-infested Soil.
Field Crock Test, Salinas, California.

Selection or Variety	MEAN WEIGHT				Difference		
	Tops		Roots		Between Infested & Non-infested		LSD 5%
	Clean	Infested	Clean	Infested	Tops	Roots	
	Soil	Soil	Soil	Soil			
	Grams	Grams	Grams	Grams			
US 41	691.0	459.7	1278.1	880.3	231.3	397.8	187.1
857-3	657.2	467.2	1546.1	1101.1	190.0	445.0	178.1
801-7	743.4	674.3	1205.5	994.6	68.6	210.9	54.1
062-11	951.5	862.6	1259.6	1253.7	88.9	5.9	211.4
050-6	842.9	865.0	1398.4	1213.9	22.1	184.5	286.6
019	894.4	988.9	1374.2	1200.4	94.5	173.8	225.0
U 074	705.3	714.8	1301.1	1109.3	9.0	191.3	231.4
033-1	1010.9	982.3	1224.8	1102.7	28.6	122.1	299.0
1089G	671.6	804.6	1363.1	1307.3	133.0	55.8	141.0
C057-15	699.7	635.7	1603.9	1268.4	64.0	335.5	124.8
1033-1	720.0	711.6	1451.1	1173.3	8.4	277.3	113.5
028	779.7	618.9	1495.2	1085.1	160.8	410.1	216.8

Some of the other selections in the test reacted differently than did the check variety, US 41. In clean soil, 062-11 had a mean top weight of 951.5 grams and a mean root weight of 1259.6 grams. The beets grown in infested soil had a mean top weight of 862.6 grams and a mean root weight of 1253.7 grams. The root weight loss of 5.9 grams and the top weight loss of 88.9 grams was not significant (5% LSD=211.4 grams). Another line that proved to be resistant was 050-6. In clean soil the mean top weight was 842.9 grams and the mean root weight was 1398.4 grams. The beets grown in infested soil had a mean top weight of 865.0 grams, while the mean root weight was 1213.9 grams. The reduction in the roots of 184.5 grams and the increase in the top weight of 22.1 grams was not significant (5% LSD=286.6 grams). There were four other selections tested that showed no significant reduction either in the amount of top or size of root when the yields from clean and nematode-infested soil were compared (Table 4). Thus, as the roots were able to resist the damaging effects of the nematode infestation, the tops also seemed to withstand the stress.

In this experiment another type of reaction occurred which was intermediate between susceptibility and resistance. In the test, in clean soil, selection C 057-15 had a mean top weight of 699.7 grams and a mean root weight of 1603.9 grams. However, in infested soil the mean top weight was 635.7 grams and the mean root weight was 1268.4 grams. The reduction in top weight of 64.0 grams was not significant (5% LSD=124.8 grams), but the reduction in root weight of 335.5 grams was significant. It was observed that the leaves of this selection died midway in the growing period and that the plants were called upon to produce a new set of leaves. This new top was produced at the expense of the root, thereby diminishing the root yield. It probably would have been possible to harvest the beets when the top growth showed the stress reaction, thereby preventing the weight loss in the roots. Perhaps selections which give this type of interaction could be grown during a shorter growing season without extensive reduction in root weight.



Figure 1. Sugarbeet seed planted in greenhouse flat in soil heavily infested with Heterodera schachtii and also containing root-rotting fungi. Line 019, selected for nematode resistance, shows remarkable resistance. US 41 is susceptible and most of the plants are dead.



Figure 2. U. S. Agricultural Research Station, Salinas, California. View of the test plot in which basic breeding lines of sugar beets that are tolerant to the sugarbeet cyst nematode are evaluated. This soil is infested with Heterodera schachtii and root-rotting fungi.

P A R T IX

NEMATOTOLOGY INVESTIGATIONS

Foundation Project 13

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Factors affecting the hatching activity of sugar-beet-root diffusate.

Arnold E. Steele and J. M. Fife^{1/}

The cuticular remains of the female of nematodes of the genus Heterodera forms a tough, sac-like cyst which may, in the absence of host plants and under favorable conditions of moisture and temperature, protect the enclosed eggs for many years.

In the presence of root exudates of host plants, eggs hatch and larvae escape from the cyst and invade host roots, where they develop to maturity and reproduce.

Shepherd (3) has recently published a review of over 300 papers which have been written on hatching and the hatching factor, but the chemical structure of no hatching factor has been established. Experiments reported here were designed to test the effect of various concentration methods on the hatching factor for the sugarbeet nematode produced by sugar beets.

Materials and Methods

Beet-root diffusate was leached from four-inch pots, each containing 3 sugarbeet seedlings (Beta vulgaris L. var. U.S. 75), by adding sufficient tap water to collect 200 ml of leachings from each pot in a 24-hour period. Fresh diffusate was obtained and treated at weekly intervals during a 6-week period. The pH of the beet-root diffusate varied from 6.0 to 6.5, whereas the total solids amounted to less than 0.5% as determined with the aid of a refractometer. All diffusate was filtered before use.

For the first experiment, the diffusate was concentrated by drying or by freezing. Fifty ml of diffusate in a 100 ml glass beaker was evaporated to dryness by continuously directing a jet of forced air down upon the surface. The dried residue was redissolved in 1,000 ml of tap water to bring the concentration to 5% of that of the untreated diffusate. A 100 ml volumetric flask containing 50 ml of diffusate was sealed with a cork stopper and placed in an inverted position in the freezing compartment of a refrigerator until only 8 to 11 ml remained unfrozen. This was separated from the ice and brought to 5% of its original concentration by addition of enough tap water to make a total of 1,000 ml. Other treatments of this test included 5% solutions of diffusate, undiluted diffusate, and tap water.

For the second experiment, the effects of beet-root diffusate, boiled for varying periods in a reflux condenser, untreated diffusate, and tap water

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on emergence of larvae from cysts of the beet nematode were compared. One hundred fifty ml aliquots of diffusate, in flasks fitted with reflux condensers, were held at boiling for 1, 2, 4, 8, 16, 32, and 64 minutes. The third experiment included an additional treatment of beet diffusate refluxed for 128 minutes.

The fourth experiment measured the effect of heating 100 ml aliquots of sugarbeet-root diffusate in a pressure cooker held at 15 pounds pressure to obtain temperatures approximately 121° C for 4, 8, 16, 32, 64, and 128 minutes. Immediately after termination of the heat treatments, the diffusates were brought to room temperature by placing the flasks in an iced water bath.

The fifth experiment was designed to determine the effects of various dilutions of beet diffusate on diffusate hatching activity. A series of graded concentrations were obtained by diluting freshly leached diffusate with tap water.

The conduct of the hatching tests of each study was essentially the same. Each treatment was replicated 4 times in separate watch glasses containing 40 *Heterodera schachtii* cysts and approximately 15 ml of treatment solution. The watch glasses, with contents, were kept in a dark, aerated cabinet in the laboratory during the 6-week test period. At weekly intervals the cysts were transferred to clean watch glasses containing fresh solutions and the emerged larvae preserved in 5% formalin until counted. Samples that contained large numbers of larvae were aliquoted for counting. Data for all tests were analysed for statistical significance by the analysis of variance method, while correlation coefficients were calculated for data presented in figure 1.

Results

Data from the first experiment listed in table 1 demonstrate that beet-root diffusate can be concentrated by drying or freezing with no measurable loss in hatching activity.

Boiling beet diffusate (second and third experiments) or heating diffusate at 15 pounds pressure (fourth experiment) for 32 minutes or longer significantly reduced the diffusate hatching activity. Figure 1 shows that hatch in treated diffusate expressed as percent of hatch in untreated diffusate is proportional to the log time of exposure to boiling or heating diffusate at 15 pounds pressure. A more rapid decline in diffusate activity was obtained by heating the diffusate to approximately 121° C (15 pounds pressure) than by boiling at atmospheric pressure. The diffusate held at the higher temperature for 64 and 128 minutes gave similar hatches which were significantly higher than tap water (Table 4).

Dilution of diffusate to 5 percent of its original concentration did not significantly alter its hatching activity. However, significantly fewer larvae hatched in diffusate diluted to 1 percent (Table 5).

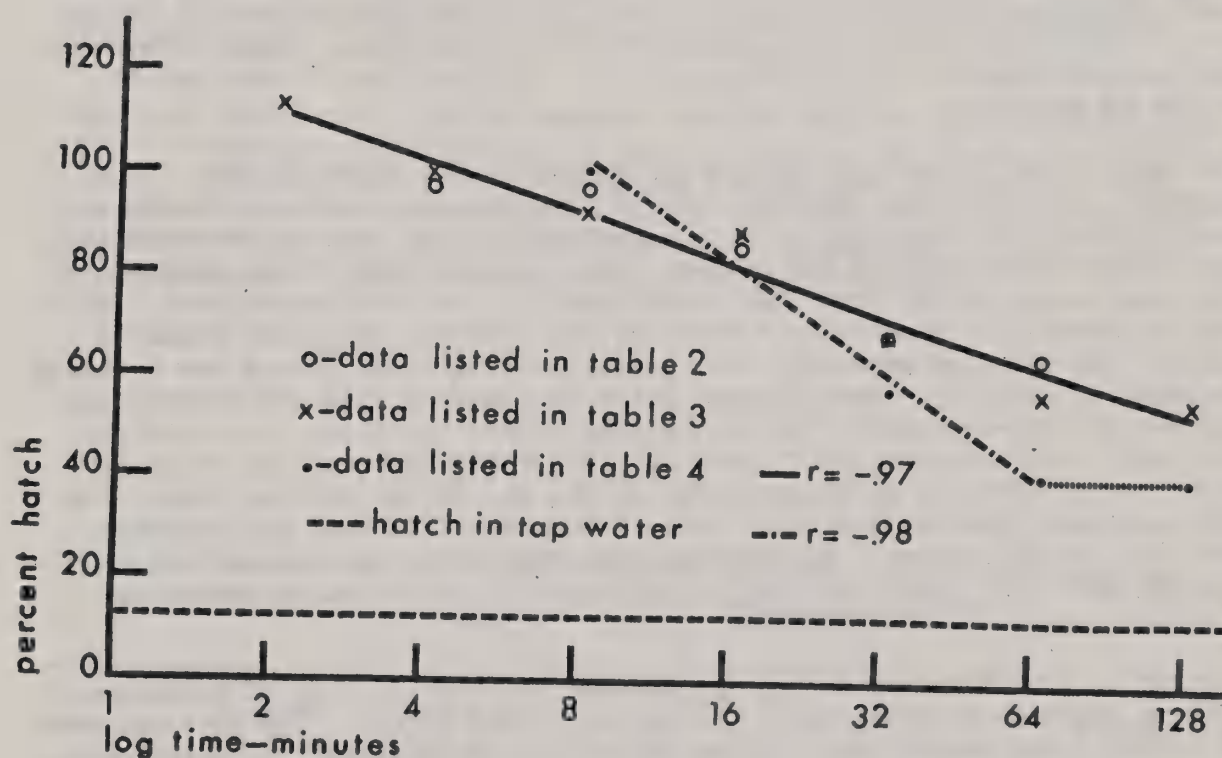


Figure 1. Effects of heat treatments on hatching activity of sugar-beet-root diffusate. The numbers of *Heterodera schachtii* larvae emerged from cysts exposed 6 weeks to treated diffusates is expressed as a percent of hatch in untreated diffusate.

Hague (2), Wallace (5), and Winslow and Ludwig (6) observed that dilution of concentrated diffusate increased its hatching activity. Increasing the dilution beyond an optimum level resulted in decreased hatches. Similar results were obtained in this study when diffusate was heated. Brief exposures of diffusate to high temperatures resulted in increased diffusate activity, whereas prolonged treatments decreased diffusate activity (Tables 2, 3 and 4).

Discussion and Conclusions

In the first experiment, it was demonstrated that concentration of beet-root diffusate by freezing or drying has no significant effect on its ability to stimulate hatching of eggs of Heterodera schachtii. A preliminary experiment, not previously reported, indicated that storage of the frozen diffusate for 11 months had no effect on activity. Viglierchio (4) has recently reported that storage at 25° C for less than 8 days has no effect on activity.

The data of the second and third experiments (Tables 2 and 3) show no significant effect with boiling times of less than 16 minutes. However, two effects were consistent in both experiments. One was the decrease in activity as compared with the control for a boiling time of one minute. This was just a little less than significant in the first experiment. With boiling times of 2 minutes or 4 minutes, the activity was about equal to that of the unboiled control. With longer boiling times, there was a steady decrease in activity. When percent hatch as compared with the control was plotted on semi-log paper, the two sets of points lie close to a straight line with a correlation coefficient of 0.97, which is excellent evidence that loss of activity is proportional to the log of the boiling time. The best estimate from the available data is that about half of the activity was lost in 128 minutes. By extrapolating the curve, it appears that a boiling period of approximately 34 hours would be required to reduce the activity to that of the tap water control.

Heating to approximately 121° C accelerated the rate of loss of activity, with no evidence of a change in the nature of the effect. The rate of loss of activity was proportional to the log of heating time with a significant correlation coefficient of -0.98. As compared with the unboiled control, about half the activity was lost by heating between 32 and 64 minutes. However, diffusate heated for 64 or 128 minutes gave similar hatches significantly higher than tap water (Table 4). Hatches in these treatments may be an osmotic effect of materials in diffusate. The presence of an osmotic effect would tend to establish a threshold below which decomposition of hatch factor could not be evaluated. Wallace (1956) demonstrated that 10⁻² molar concentrations of urea, sodium chloride, and sucrose increased hatching of sugar-beet nematode by as much as 2 to 4 times the amount of hatch in distilled water.

Dilution of the diffusate in experiment No. 5 had no significant effect at 5%, though there was a steady decrease in activity between 75% and 5%. At 1% dilution the effect was significant, and at 0.1%, activity approached that

of the control. This would indicate that there is no sharp optimum dilution as reported by Hague (1) for potato-root diffusate and Heterodera rostochiensis.

The data from these experiments show that the hatching factor for Heterodera schachtii produced by sugarbeets is not affected by freezing and drying, that it loses activity only slowly on boiling and more rapidly by heating at about 121° C, and that there is no sharp optimum concentration. While this information provides no definite clues to the chemical identity of the hatching factor, it does permit the elimination of substances which are rapidly decomposed by boiling or by heating to about 121° C from consideration. On the positive side, it has been shown that the hatching factor is slowly inactivated by heat in the range tested.

Hague was not certain whether reduced hatch at higher concentrations were due to inhibition salts present in the diffusate or to the factor itself. Wallace suggested that reduced hatch may result from an osmotic effect exerted by salts at concentrations higher than optimum; however, similar hatching effects were obtained in this study by heating diffusate under conditions which did not decrease the salt concentration.

Table 1. The effects of concentration of sugarbeet-root diffusate by freezing or drying on diffusate hatching activity.^{1/}

Treatment solution	Method of concentration	% concentration	Replications				Total	Average
			1	2	3	4		
Tap water	-	-	1,800	2,180	1,980	1,900	7,860	1,965
Beet diff.	Frozen	5	7,670	7,130	5,750	5,720	26,270	6,568
"	"	Dried	5	5,820	7,460	8,570	6,560	28,410
"	"	None	5	6,470	8,900	8,460	5,850	29,680
"	"	None	100	10,140	6,820	8,940	8,300	34,200
Significance								
LSD .05								1,801

^{1/}Figures indicate the total numbers of larvae emerged from 40 cysts exposed 6 weeks to the various treatments.

Table 2. The effects of boiling sugarbeet-root diffusate on diffusate hatching activity.^{1/}

Treatment	Boiling time	Replications				Total	Average	% ^{2/}
		1	2	3	4			
Tap water	0	330	620	1,180	780	2,910	728	10.2
Beet Diff.	0	4,440	6,340	9,620	8,210	28,610	7,153	100.0
" "	1	4,800	4,740	7,340	5,730	22,610	5,653	79.0
" "	2	5,260	8,110	6,990	6,760	27,120	6,780	94.8
" "	4	7,160	6,250	7,480	6,960	27,850	6,963	97.3
" "	8	4,970	7,050	8,480	7,380	27,880	6,970	97.4
" "	16	3,780	5,330	8,220	7,390	24,720	6,180	86.4
" "	32	2,770	6,620	5,290	5,140	19,820	4,955	69.3
" "	64	3,530	6,380	4,970	4,340	19,220	4,805	67.2
LSD .05							1,510	21.1

Table 3. The effects of boiling sugarbeet-root diffusate on diffusate hatching activity.^{1/}

Treatment	Boiling time	Replications				Total	Average	% ^{2/}
		1	2	3	4			
Tap water	0	760	1,040	880	810	3,490	873	14.7
Beet diff.	0	6,070	5,330	6,350	5,950	23,700	5,925	100.0
" "	1	5,120	4,940	5,450	6,140	21,650	5,413	91.4
" "	2	7,620	7,490	5,400	5,980	26,490	6,623	111.8
" "	4	5,300	5,480	7,170	5,770	23,720	5,930	100.1
" "	8	4,800	6,190	5,570	5,390	21,950	5,488	92.6
" "	16	4,320	5,160	6,200	5,600	21,280	5,320	89.8
" "	32	4,280	3,500	5,900	2,740	16,420	4,105	69.3
" "	64	3,920	3,350	4,200	2,550	14,020	3,505	59.2
" "	128	3,800	3,550	2,830	3,180	13,360	3,340	56.4
LSD .05							1,114	18.8

^{1/} Figures indicate the total number of larvae emerged from 40 cysts exposed 6 weeks to the various treatments.

^{2/} Percent of hatch in unboiled beet-root diffusate.

Table 4. The effects of heating sugarbeet-root diffusate at 15 pounds pressure on diffusate hatching activity.^{1/}

Treatment	Heating time	Replications				Total	Average	% ^{2/}
		1	2	3	4			
Tap water	-	1,489	1,610	1,993	1,561	6,653	1,663.3	15.1
Beet diff.	0	12,310	10,754	11,015	9,880	43,959	10,989.8	100.0
" "	4	10,791	10,216	11,261	12,213	44,481	11,120.3	101.2
" "	8	12,172	11,448	10,431	10,725	44,776	11,194.0	101.9
" "	16	9,175	10,859	10,037	9,371	39,442	9,860.5	89.7
" "	32	6,300	6,310	6,644	7,056	26,310	6,577.5	59.9
" "	64	5,369	4,367	4,030	4,684	18,450	4,612.5	42.0
" "	128	4,691	4,265	4,263	4,972	18,191	4,547.8	41.4
LSD .05							1,018.0	9.2

Table 5. Total numbers of *Heterodera schachtii* larvae emerged from cysts exposed 6 weeks to various concentrations of beet-root diffusate.

Diffusate treatment ^{3/}	Replications				Total	Average	% ^{4/}
	1	2	3	4			
100	13,676	11,552	8,364	8,972	42,564	10,641.0	100.0
75	16,080	9,266	10,036	8,382	43,764	10,941.0	102.8
50	11,923	9,695	10,670	9,868	42,156	10,539.0	99.1
25	11,014	9,699	10,387	9,862	40,962	10,240.5	96.2
10	10,895	9,059	9,406	9,079	38,439	9,609.8	90.3
5	10,742	11,059	10,713	6,205	38,719	9,679.8	91.0
1	9,221	6,660	7,072	7,475	30,428	7,607.0	71.5
.1	4,705	6,202	4,885	4,840	20,632	5,158.0	48.5
0	5,078	4,001	4,686	3,989	17,754	4,438.5	41.7
LSD .05						2,051.1	19.3

^{1/}Figures indicate the total number of larvae emerged from 40 cysts exposed 6 weeks to the various treatments.

^{2/}Percent of hatch in unboiled beet-root diffusate.

^{3/}Percent concentration of beet-root diffusate in tap water.

^{4/}Percent of hatch in undiluted beet-root diffusate.

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The efficacy of various legume crops in controlling

Heterodera schachtii.

Arnold E. Steele and Charles Price

In studies of rotation systems on nematode infested land, Johnson and Wheatley (1959) found that inclusion of beans in the rotation greatly increased yields of sugarbeets. Golden and Shafer (1959) demonstrated that beans had a stimulatory trap crop effect on larvae of the beet nematode and suggested that beans might have some practical value in rotation systems for the control of this pest.

Jones (1955, 1956a, and 1956b) found that some of the difficulties associated with population studies using field plots were overcome when microplots were used. Microplots described by this worker were constructed of slotted concrete posts and paving stones joined together with bitumastic and measured 2 feet 4 inches square and two feet deep. Mai (1958) reported successful use of 8 x 5 feet plots bounded by 12-inch redwood boards for research involving the golden nematode, Heterodera rostochiensis. The success of these workers suggested that similar microplots might be used to study the efficacy of various legume crops for controlling the sugarbeet nematode, Heterodera schachtii.

Materials and Methods

Twenty-five bins, measuring 4 feet square and 3 feet deep, were constructed of 3/4" x 12" redwood, lined with polyethylene plastic sheeting, and sunk into the ground to a depth of 2 1/2 feet. Aluminum nails were used in the construction of the bins. Individual bins were placed 4 feet apart. Examination of the soil in the experimental area did not reveal the presence of nematode cysts.

Sugarbeets (Beta vulgaris L. var. U.S. 75) were grown in individual aluminum foil cylinders containing steam-sterilized soil. When the plants were well established, the aluminum foil was removed and 16 beets transplanted to each bin. Infested soil was added to one-half of the plots at the time the beets were transplanted.

Soil samples were obtained from each plot on March 9, 1961, after beets had been removed. The samples were oven dried, weighed, and processed to recover cysts. Cyst counts of samples appear in table 1.

Legume crops were planted on April 25, 1961, and May 25, 1962. Each of the crops were replicated 5 times in a randomized block design. Crop treatments were as follows: Kentucky wonder white-seeded pole beans (Phaseolus vulgaris L.), Small white navy beans (Phaseolus vulgaris L.), Telephone dark-podded peas (Pisum sativum), White Dutch clover (Trifolium repens), and Chilean alfalfa (Medicago sativa). Each plot receiving peas or beans contained 4 planting rows spaced 1 foot apart, while seeds of clover or alfalfa were broadcast planted.

Table 1. Numbers of cysts of Heterodera schachtii per 100 grams of soil.

Sampled March 9, 1961

	Replications					Total	Average
	1	2	3	4	5		
Navy beans	42	46	40	63	56	247	49.4
Clover	38	52	64	36	57	247	49.4
Alfalfa	36	49	59	67	35	246	49.2
Pole beans	47	62	31	50	51	241	48.2
Peas	42	62	37	64	39	244	48.8
Total	205	271	231	280	238	1,225	

Sampled October 25, 1961

Navy beans	19	23	31	27	23	123	24.6
Clover	26	40	62	22	28	178	35.6
Alfalfa	30	35	37	31	25	158	31.6
Pole beans	26	23	17	29	27	122	24.4
Peas	30	40	18	17	25	130	26.0
Total	131	161	165	126	128	711	

Sampled October 25, 1962

Navy beans	23	37	28	36	28	152	30.4
Clover	20	21	23	23	31	118	23.6
Alfalfa	25	36	27	33	29	150	30.0
Pole beans	26	30	23	36	34	149	29.8
Peas	34	30	17	23	25	129	25.8
Total	128	154	118	151	147	698	

Sampled October 10, 1963

Navy beans	351	91	100	118	127	787	157.4
Clover	109	139	179	136	87	650	130.0
Alfalfa	100	99	123	154	93	569	113.8
Pole beans	132	68	103	165	125	593	118.6
Peas	109	82	105	220	101	617	123.4
Total	801	479	610	793	533	3,216	

Table 2. Weight of 50 sugarbeet plants sampled from each plot on March 12, 1963. (grams)

	Replications					Total	Average
	1	2	3	4	5		
Navy beans	1.40	1.85	1.20	1.35	1.50	7.30	1.46
Clover	2.00	1.70	2.00	1.50	2.60	9.80	1.96
Alfalfa	1.30	2.05	1.95	1.45	2.10	8.85	1.77
Pole beans	1.60	1.65	1.40	2.10	1.25	8.00	1.60
Peas	1.40	1.10	1.65	1.60	1.45	7.20	1.44
Total	7.70	8.35	8.20	8.00	8.90	41.15	

Table 3. Number of beet-nematode larvae per plant sampled March 12, 1963.

	Replications					Total	Average
	1	2	3	4	5		
Navy beans	22.5	18.7	13.2	17.1	12.4	83.9	16.8
Clover	7.8	6.8	27.0	6.5	10.6	58.7	11.7
Alfalfa	6.8	5.0	9.3	11.1	8.2	40.4	8.1
Pole beans	24.3	10.7	5.1	44.9	29.5	114.5	22.9
Peas	12.9	18.2	16.3	28.1	21.9	97.4	19.5
Total	74.3	59.4	70.9	107.7	82.6	394.9	

Table 4. Average number of larvae per gram of roots of beet plants sampled March 12, 1963.

	Replications					Total	Average
	1	2	3	4	5		
Navy beans	797	504	554	646	412	2,913	582.6
Clover	196	397	676	188	205	1,662	332.4
Alfalfa	260	122	238	381	196	1,197	239.4
Pole beans	752	320	178	1,077	1,203	3,530	706.0
Peas	463	835	488	884	750	3,420	684.0
Total	2,468	2,178	2,134	3,176	2,766	12,722	
L.S.D. .05							353.3

Table 5. Weights of sugarbeets harvested October 2, 1963. (lbs.)

	Replications					Total	Average
	1	2	3	4	5		
Navy beans	0.93	0.98	1.05	0.90	0.90	4.76	0.95
Clover	0.70	1.00	1.18	1.09	1.29	5.26	1.05
Alfalfa	1.03	1.10	0.98	1.18	1.11	5.40	1.08
Pole beans	0.75	0.98	1.00	0.83	0.69	4.25	0.85
Peas	0.93	1.17	1.00	1.26	1.03	5.39	1.08
Total	4.34	5.23	5.21	5.26	5.02	25.06	

Random samples were obtained from each plot on October 25, 1961, and October 25, 1962, after legume crops were removed from the plots. The samples were oven dried, weighed, and processed to recover cysts. Cyst counts of these samples appear in tables 2 and 3.

Seed of sugarbeets were planted in each of the 25 plots on February 4, 1963. On March 12, 1963, several plants were removed from each plot and taken to the laboratory, where the plants were washed and weighed and the roots stained in a boiling solution of lactophenol and examined for the presence of nematode larvae. Data on plant weights and counts of larvae are listed in tables 2, 3, 4, and 5.

Beets were thinned to 20 plants per plot on March 14, 1963, and harvested and weighed on October 2, 1963. Soil samples taken on October 10, 1963, were oven dried, weighed, and processed to recover cysts. Plant weights and cyst counts appear in tables 5 and 1, respectively.

Results and Conclusions

There were no significant differences in cyst populations between crop treatment on any of the sampling dates. However, clover or alfalfa reduced cyst populations slightly more than did peas or beans (table 1). The data indicate that the nematode-trapping effect of these legumes when grown 2 seasons following beets was not sufficient to appreciably lower soil populations of sugarbeet nematode cysts.

Investigations to Determine the Influence of
Fallow on the Decline of Soil Populations of Heterodera schachtii

by

Arnold E. Steele and Charles Price

Published information on survival of nematodes is based largely upon results of short-term laboratory or greenhouse studies that involve a limited number of nematodes. Studies are usually designed to determine the maximum time individuals will survive. Few attempts have been made to test populations whose members are of a definite and determinable age. Consequently, information of this nature is of limited value. Therefore, a study has been initiated to determine the rate of decline of cyst populations of Heterodera schachtii as influenced by length of fallow. The study will be conducted over a period of several years and is expected to yield information that may have practical application or serve as a guide for additional research.

The study is being undertaken in microplots located in a field at the U. S. Agricultural Research Station, Salinas, California. The microplots consist of 25 redwood bins, measuring 4 feet square, 3 feet deep, and sunk into the ground to a depth of $2\frac{1}{2}$ feet. The bins are 4 feet apart and arranged in a 5' x 5' square design.

Soil samples of plots taken over the last three years have not contained cysts of Heterodera schachtii.

Nematode cysts, obtained by washing and screening soil of greenhouse cultures, were broken open and the eggs, larvae, and cyst walls inoculated on 210 seedlings of Beta vulgaris L. (Var. U.S. 75) at the rate of 30 cysts per plant. The inoculated plants were grown in aluminum foil cylinders in the greenhouse for 30 days so that larvae would not be adversely affected by extremes of moisture and/or temperature and will have an opportunity to invade beet roots. At the end of 30 days the plants were carefully removed from cylinders and transplanted to microplots, care being taken not to disrupt the column of soil adhering to the roots. In this way, twenty infested plants were transplanted in 4 rows in each of 5 plots on a given date. The entire process was repeated at intervals, until all 25 plots contained infested plants. Beet seedlings were inoculated on October 2, 1962, January 4, 1963, April 2, 1963, June 2, 1963, or August 2, 1963. Beets were harvested from all plots on October 2, 1963. At this time plots contained plants infested for 2, 4, 6, 9, or 12 months. Soil samples obtained from each plot were oven dried, weighed, and processed to recover sugarbeet nematode cysts.

As shown in figure 1, the numbers of cysts recovered from samples were proportional to the length of time beets were grown in the plots. However, the percent of cysts which were viable (contained eggs and larvae)

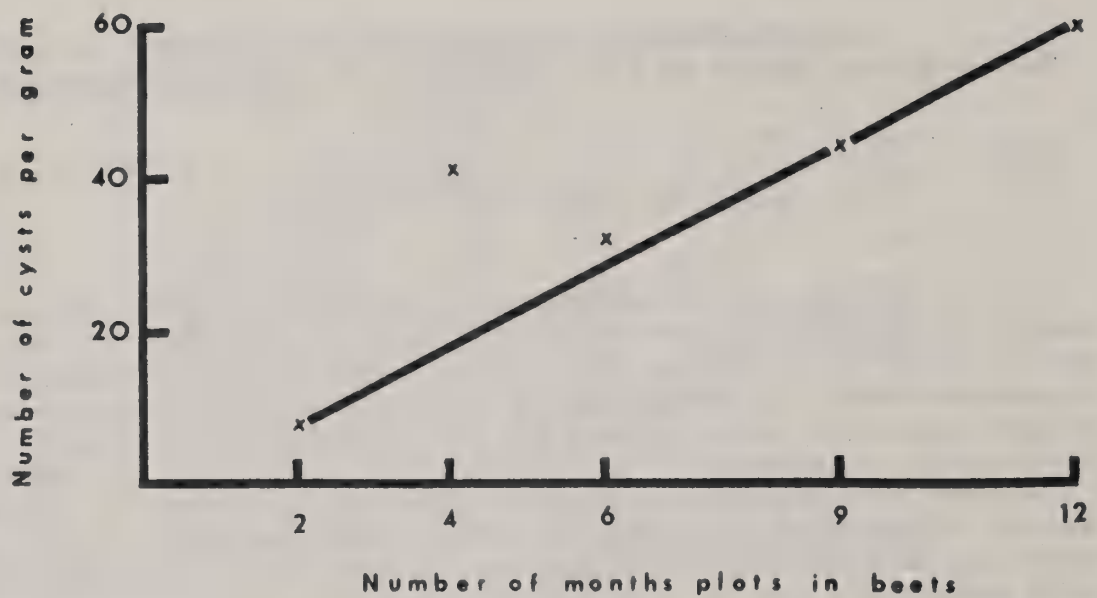


Figure 1. Influence of length of infection on increase of cyst populations.

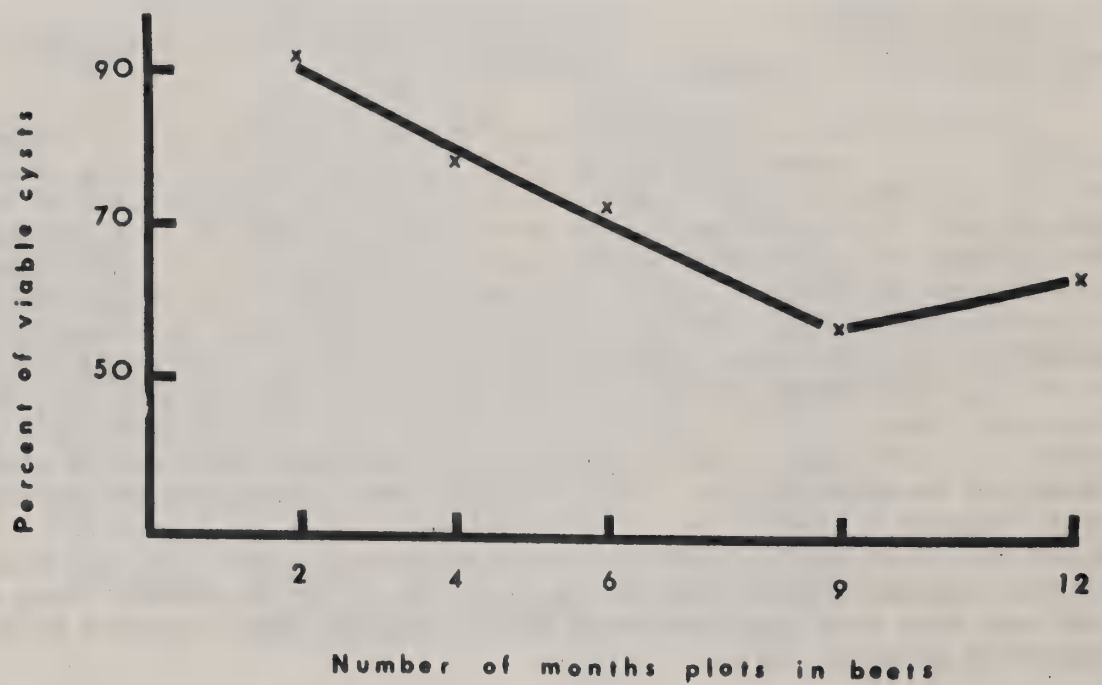


Figure 2. Influence of age on decline of viability of cyst populations.

decreased with increase of time up to 9 months (figure 2). At 9 months only 57 percent of the cysts contained eggs and larvae, whereas 64 percent of cysts recovered from plots in which beets were grown 12 months.

The plots will be fallowed for a number of years. Soil samples will be taken at intervals and examined to determine the rates of decline of cyst populations and the viability of cyst contents.

Table 1. Number of cysts per 100 grams soil sampled
October 14, 1963.

Age of Cyst Population (months)	Replications					Total	Average
	1	2	3	4	5		
2	7	4	3	2	7	23	4.6
4	36	30	52	34	49	201	40.2
6	38	17	42	35	19	151	30.2
9	35	29	83	25	42	214	42.8
12	37	45	31	108	68	289	57.8
Total	153	125	211	204	185	878	
L.S.D.	.05						42.6

Table 2. Influence of age on decline of viability of
cyst populations.

Age of Cyst Population (months)	Replications					Total	Average
	1	2	3	4	5		
2	71.4 ^{1/}	80.0	100.0	100.0	100.0	451.4	90.3
4	91.9	71.0	75.0	76.5	82.0	396.4	79.3
6	60.5	75.0	82.9	61.8	82.1	362.3	72.5
9	41.7	58.6	43.9	64.0	74.4	282.6	56.5
12	50.0	51.1	77.4	73.1	67.6	319.2	63.8
Total	315.5	335.7	379.2	375.4	406.1	1,811.9	
L.S.D.	.05						14.3

^{1/} Figures are percent of cysts containing eggs and larvae.

P A R T X

VIRUS YELLOWS INVESTIGATIONS^{1/}

and

BREEDING FOR YELLOWS RESISTANCE^{2/}

Foundation Project 12

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^{1/} Investigations supported in part by funds received from California Beet Growers Association, Limited, under Cooperative Agreement.

^{2/} Field test at Davis, California, conducted in cooperation with California Agricultural Experiment Station.

RELATIVE ECONOMIC IMPORTANCE OF BEET YELLOWS AND
BEET WESTERN YELLOWS IN WESTERN
UNITED STATES

C. W. Bennett

During the past several years efforts have been made by surveys and by other means to determine the incidence and geographic range of the two chief beet yellowing viruses, beet yellows virus (BYV) and beet western yellows virus (BWYV) in western United States. Surveys have been made at intervals, various people associated with the beet industry have been consulted, and more than a thousand beets from different sugarbeet-producing areas of western United States have been assayed for virus content. Attempts have been made also to evaluate the virulence of virus isolates taken from beets from widely separated areas of the western states.

Geographic Distribution

The evidence available from these studies indicates that yellowing of beets is widespread and may occur in any of the beet-growing areas in the western half of the country. However, incidence of infection and type of virus involved vary greatly. So far as has been determined, beet yellows is largely limited to California, but it occurs also in the seed-producing areas of Arizona. Its prevalence and destructiveness are associated with and probably largely dependent on the presence of beets throughout the year. Complete destruction of all beets in an area, even for a short period in the year, has markedly reduced the incidence of beet yellows. This has been true also for beet mosaic.

Beet western yellows is much more widely distributed than beet yellows. It probably occurs throughout the United States, but its presence is most clearly evident in beet fields of the western part of the country. The causal virus is widely distributed in a number of weed plants in which it probably can persist in the absence of beet plantings. However, as with beet yellows, the presence of beet plants throughout the year favors earlier and more widespread infection. Many beet fields throughout California have a high percentage of infection by the first of June. The seed areas in Arizona and Oregon also usually show a high percentage of infection before harvest. In 1962 western yellows was observed in many fields in Utah, Idaho, Washington and Oregon. Except for one small area in southern Washington, incidence of infection was very low, in many fields amounting to only a few plants per acre. Yellowing of beets has been reported in some fields in Colorado during different years, and diseased beets have been obtained from Montana.

"Beet mild yellows" reported to be prevalent in England, has a number of characteristics in common with beet western yellows in the United States. However, the exact relationship between the two diseases and their causal viruses has not been determined.

Evaluation of Virulence of Isolates of Beet Yellows and Beet Western Yellows Viruses

Reasonably extensive studies of strains of beet yellows virus have been made and reported. The range of virulence of strains of this virus is appreciable, but even the less virulent strains are capable of causing considerable damage. Unfortunately, most of the isolates of this virus from sections where it has been found have a high degree of virulence. Maximum damage caused by beet yellows in extensive tests over a period of 12 years has ranged from about 20 to about 60 percent, depending largely on the beet selection tested. Maximum damage to commercial varieties is usually from 30 to 40 percent.

Since western yellows is more widespread than beet yellows, it is highly important to determine the range of virulence of strains of the virus and the damage various strains are capable of producing and also the range of resistance of different varieties and selections of sugarbeet. Therefore, tests have been made both in the greenhouse and in the field over the past three years to obtain further information on damage strains of this virus are capable of producing. Results of two years of field testing in cooperation with J. S. McFarlane, using one strain each of beet yellows and beet western yellows viruses have been reported (See Sugarbeet Research 1961 and 1962 Reports). Further greenhouse tests and the results of the 1963 field tests are presented in this report.

Greenhouse Tests. Several tests to determine relative damage caused by various isolates of beet western yellows virus have been made. Seeds were planted in 6-inch pots and the seedlings were thinned to 4 plants per pot when they were in the cotyledon stage. The plants were inoculated with the selected virus isolate when they were in the 4-leaf stage. After approximately three months the plants were harvested and weighed. It has been found that there is considerable variation in size of plants under these conditions and it is not considered that results of pot tests are as reliable as replicated field tests. However, by using relatively large numbers of plants, results have been obtained that give some indication of general effects of different virus isolates on different beet selections.

Results of two of these tests are shown in Tables 1 and 2. Plants used in the test shown in Table 1 were inoculated with an isolate of beet western yellows virus from near Salinas, California which came from a beet showing very marked yellowing. It was selected as one of the more virulent strains of BWYV on the basis of origin and its effects on greenhouse plants. The beet yellows inoculations were made with an isolate called "Strain 5" known from field and greenhouse tests to be a virulent strain of this virus.

A BWYV isolate from Longmont, Colorado, and a BYV isolate from Grimes, California, were used for the test, results of which are shown in Table 2. Greenhouse tests indicated that the BWYV Longmont strain, had a relatively high virulence and the BYV isolate is even more virulent than strain 5 used in the first test.

Table 1. Root yields of sugarbeet selections in the greenhouse as affected by beet western yellows and beet yellows, singly and in combination. BWYV - Salinas, California; BYV - Strain 5.

Variety or Selection	Percent reduction in root weight		
	BWY	BY	BWY + BY
F58-86H7	11.4	28.6	46.8
F56-66H2	4.1	17.3	42.8
F59-63H1	2.7	16.1	20.0
US 201B	6.4	24.8	48.6
512	.4	9.4	10.0
IRS 5904	5.2	+7	12.7
SL 8096	+5.2	23.4	27.7
5511	+3.4	33.2	33.6
57 EL-42S	4.6	21.7	25.0

Table 2. Root yields of sugarbeet selections in the greenhouse as affected by beet western yellows and beet yellows, singly and in combination. BWYV - Longmont, Colorado; BYV - Grimes, California.

Selection	Percent reduction in root weight		
	BWY	BY	BWY + BY
S1	0.0	27.5	27.5
952	2.8	28.9	32.7
F61-569H1	10.6	21.2	34.6
163H5	12.4	33.3	42.3
F59-509H1	32.7	52.4	54.5
F58-554H1	1.9	29.1	31.0
1768C2	.9	24.3	25.0
F59-509	.8	33.6	32.0
F58-554	5.8	35.3	36.7
0716	13.8	36.7	37.6
1757C2	1.7	7.0	33.9
1760C2	+2.3	27.3	29.5
5502	+9.6	19.4	24.3
5511	1.0	36.9	44.7

There are some inconsistencies in the results in both Table 1 and Table 2, probably due to variation in the growth of plants in pots under greenhouse conditions, but the results indicate that each of the isolates of BWYV causes much less damage than was produced by the two isolates of BYV.

In a third test (Table 3) the effects of isolates of BWYV from different locations were compared with the effects of three isolates of BYV on US 75. Strain 1 of BYV is one of the milder isolates of this virus, whereas strain 5 and the isolate from Grimes are highly virulent.

All of the isolates of BWYV produced less damage than the more virulent isolates of BYV, and all but one produced less damage than the less virulent strain of BYV. Isolates of BYV and BWYV were selected on the basis of this test for further comparison in field plots at Davis, California, in 1963.

Field Test. For further testing of the effect of different isolates of BYV and BWYV under field conditions, two isolates of BYV and four isolates of BWYV were selected for use in plot inoculations at Davis. The BYV isolates consisted of the highly virulent strain 5 and a less virulent strain 1. The BWYV isolates were selected on the basis of apparent virulence under greenhouse conditions, and an attempt was made to select isolates to cover a range of virulence.

The test planting was made with the monogerm variety 539H1 June 4; plots were inoculated July 22 and harvested December 5. The plots were two rows wide and fifty-four ft long. There were five replications.

Symptoms of beet yellows began to appear about 20 days after inoculation, and yellowing was quite evident four weeks after inoculation. The plots inoculated with the virulent BYV strain 5 were more yellow than those inoculated with the less virulent BYV strain 1, throughout the season. Plants inoculated with isolates of BWYV began to show yellowing about 30 days after inoculation, but yellowing was not so marked as with the BYV isolates. The low degree of yellowing by BWYV probably resulted from the relatively high nitrogen level of the soil of the experimental area. Sugarbeets that are infected with BWYV can be almost wholly prevented from turning yellow by high nitrogen applications. This is not equally true with beets with beet yellows.

Both root weight and sugar were significantly reduced by all isolates of both viruses (Table 4). Reductions in root yield by BYV strains 5 and 1 were 41.7 and 24.1 percent, respectively. These reductions are of the same order as those produced in other field tests with these viruses, and they indicate roughly the range of damage that can be produced by strains of BYV of different degrees of virulence, although one strain of this virus is known which is more virulent than strain 5 used in this test.

Table 3. Reduction in root yield of sugarbeet by different isolates of beet yellows and beet western yellows viruses in the greenhouse. Inoculated 2-28-63; harvested 5-6-63. 80 plants US 75 per test.

Virus used and source	Percent reduction in root weight
BWYV, Salinas, Calif.	10.5
BWYV, Salem, Ore.	17.4
BWYV, Rocky Ford, Colo.	.6
BWYV, Longmont, Colo.	13.9
BWYV, Pocatello, Idaho	23.3
BWYV, Sand Valley, Calif.	18.0
BWYV, Mesa, Ariz.	+1.7
BWYV + BYV, Mesa, Ariz.	26.1
BYV, Salinas, Calif., St. 1	20.9
BYV, Salinas, Calif., St. 5	31.3
BYV, Grimes, Calif.	40.7

Table 4. Reduction in yield and sucrose in sugarbeet (var. 539H1 monogerm) by strains of beet yellows and beet western yellows viruses at Davis, California, 1963.

Virus used as inoculum	Reduction in yield		Reduction in sucrose
	Sugar	Beets	
	Percent	Percent	Pct. pts.
BYV, strain 5	42.7	41.7	0.24
BYV, strain 1	26.1	24.1	0.39
BWYV, Rocky Ford, Colo.	16.5	13.7	0.46
BWYV, Four Corners, Calif.	12.3	11.2	0.21
BWYV, Sand Valley, Calif.	21.3	18.2	0.55
BWYV, Salem, Ore.	13.4	10.8	0.42
LSD (5%)	6.1	5.0	NS

There was appreciable variation in the reduction in root weight by the different isolates of BWYV, but the damage in all instances was less than that produced by the less virulent strain of BYV, and it was less than half that produced by the more virulent strain of this virus. The range of reduction in root weight (10.8-18.2%) by isolates of BWYV probably reflects degree of virulence among the isolates. In selecting these isolates for field test an effort was made to select isolates with a range of virulence based on greenhouse results. On the basis of greenhouse tests the isolates were rated Rocky Ford, Four Corners, Salem, and Sand Valley, in ascending order of virulence. The isolates fell in this order in the field test, except that the Rocky Ford isolate caused more damage than was expected. In the greenhouse this isolate has caused no significant reduction in root weight (Table 3).

All isolates of both viruses reduced sugar percent. These reductions ranged from 0.21 to 0.55 of a percentage point. None of these reductions was statistically significant. Reduction in sugar percent by yellows viruses has been one of the most variable effects of both beet and beet western yellows. In some tests in previous years the reduction in percent sugar has been marked and highly significant; in others it has not reached significance. The factors causing these results are wholly unknown.

Conclusions

Results of the tests described in this report, as well as results from field tests conducted earlier in cooperation with J. S. McFarlane (See Sugarbeet Research 1961 and 1962 Reports), indicate that beet yellows is capable of producing much greater reductions in yield than beet western yellows. It would appear that the reduction by beet western yellows might be less than half that expected from beet yellows.

There is evidence that beet yellows can be effectively controlled by certain sanitary measures, such as destroying wild and escaped beets and providing for a beet-free period where this is possible. These measures also affect the incidence and time of infection with beet western yellows, but they are not so effective in controlling beet western yellows as they are in controlling beet yellows. The reason for this difference is that most of the beet yellows virus for infection of beet fields comes from beets, whereas beet western yellows virus may come from a number of weed plants in addition to beets.

The lesser damage produced by beet western yellows, therefore, is highly significant economically. Where beet yellows is controlled or is not present, losses from beet western yellows, while they may be substantial, are not likely to be catastrophic, whereas high percentages of infection with beet yellows, which nearly always also involves high percentages of infection with beet western yellows and beet mosaic, may produce very large reductions in yield as has been demonstrated in several areas in California during the past few years.

RESULTS OF 1963 YELLOWS RESISTANCE EVALUATION TESTS^{1/}

J. S. McFarlane, C. W. Bennett, and I. O. Skoyen

The only way to accurately determine the resistance of a sugar-beet variety or breeding line to yellows is to compare the performance of inoculated and noninoculated plots. To obtain an accurate comparison, the noninoculated plots must be maintained free of infection. Aphid populations remain high at Salinas during the entire growing season, and experience has shown that the spread of yellows cannot be prevented even though the plots are sprayed frequently with an aphicide. Arrangements have therefore been made with the University of California to do the evaluation work on the Agronomy farm at Davis. By delaying planting until the aphid population has dropped to a low level, little difficulty has been experienced at Davis in maintaining infection at a low level in the noninoculated plots.

Plans and Procedures

Evaluation tests were planted at Davis on May 21 and irrigated June 4. One test was designed to determine the resistance of three hybrid monogerm varieties to both beet and western yellows. The treatments, consisting of a noninoculated check, a beet-yellows inoculation, a western-yellows inoculation, and a combination beet and western-yellows inoculation were arranged in randomized strips across each of four replications. The variety subplots were two rows wide and 54 feet long.

A second test consisting of nine open-pollinated yellows-resistant selections, two unselected parent varieties, and a tetraploid line was planted to determine resistance to the combination of beet and western yellows. The variety subplots were two rows wide by 43 feet long and were replicated five times. A third test consisting of six hybrid varieties was planted in a similar manner to determine resistance to the combination of beet and western yellows. Using a similar design, a fourth test was planted to measure the resistance of seven F_1 hybrids, an open-pollinated line, and eight inbreds to western yellows.¹ The hybrids and inbreds were randomized as separate groups.

Stand counts were made following thinning and plant populations were adjusted so that a similar number of plants remained in the inoculated and noninoculated plots of any given variety in each replication. Inoculations were made July 22 with virulent strains of beet yellows and beet western yellows viruses. Ratings for yellowing and stunting were made October 4. The beets were harvested December 2-7.

^{1/} The assistance of Dr. F. J. Hills of the University of California in arranging and caring for the tests is gratefully acknowledged.

Results

High levels of infection were obtained with both beet and western yellows viruses in all inoculated plots. Almost no yellows spread to the noninoculated check plots. Stands were light in a few hybrid and open-pollinated varieties and in several of the inbreds. Pronounced yellowing and stunting occurred in plots inoculated with beet yellows virus and with the combination of beet and western yellows viruses. Little or no difference was observed in the appearance of plots inoculated with beet yellows virus alone and with the combination of viruses. Plots inoculated with western yellows virus showed very mild yellowing and very little stunting. Root yields were high for the relatively short six-month growing season. Sucrose percentages tended to be low.

The three monogerm hybrid varieties 539H1, 539H4, and 63H4 showed similar losses of root yield and sucrose percentage when inoculated with beet yellows virus and also when inoculated with western yellows virus (tables 1 and 2). Root yield losses from the combination of beet and western yellows ranged from 35.1 percent for 539H4 to 41.4 percent for 63H4, and the difference between varieties was significant.

Yield losses from western yellows averaged 19.9 percent; those from beet yellows, 35.3 percent; and those from the combination of viruses, 38.7 percent. Losses in sucrose content averaged 0.146 percentage points for western yellows, 0.23 percentage points for beet yellows, and 1.14 percentage points for the combination of viruses (table 1).

The average root yield of the three varieties inoculated with western yellows virus was significantly lower than that of the non-inoculated checks. The average root yield of varieties inoculated with beet yellows virus and with the combination of beet and western yellows viruses was significantly lower than for those inoculated with western yellows virus. There was no significant difference in the yield of varieties inoculated with beet yellows virus and those inoculated with the combination of viruses. The average sucrose percentage of the varieties inoculated with the combination of beet and western yellows viruses was significantly lower than that of the same varieties inoculated with beet yellows virus alone, western yellows virus alone, or of the noninoculated plots. The interaction between varieties and virus treatments was not significant (table 2).

Table 1. Reduction in yield and sucrose percentage of sugarbeet hybrids when inoculated with western yellows, beet yellows, and the combination of beet and western yellows viruses at Davis, California, in 1963.

Treatment	Variety or Selection			LSD (5%)
	539H1	539H4	63H4	
<u>Percent Reduction in Gross Sugar</u>				
Western yellows	23.4	21.4	24.1	NS
Beet yellows	35.9	34.1	38.4	NS
Beet & western yellows	45.8	39.8	46.7	1.1
<u>Percent Reduction in Yield of Roots</u>				
Western yellows	19.2	19.3	21.2	NS
Beet yellows	34.7	33.7	37.5	NS
Beet & western yellows	40.0	35.1	41.1	3.0
<u>Percentage Points Reduction in Sucrose</u>				
Western yellows	0.61	0.34	0.44	NS
Beet yellows	0.28	0.18	0.23	NS
Beet & western yellows	1.23	0.90	1.29	NS

Table 2. Effect of western yellows, beet yellows, and the combination of beet and western yellows on the performance of sugarbeet hybrids at Davis, California, in 1963.

Treatment	Variety or Selection			Ave.	LSD (5%)
	539H1	539H4	63H4		
<u>Gross Sugar Yield in Pounds per Acre</u>					
Check	7250	7120	8160	7510	436
Western yellows	5560	5590	6190	5780	NS
Beet yellows	4640	4680	5010	4780	NS
Beet & western yellows	3930	4280	4340	4180	NS
LSD (5%) for treatments (average of all varieties)=351					
<u>Root Yield in Tons per Acre</u>					
Check	28.4	29.3	31.2	29.7	NS
Western yellows	23.1	23.7	24.6	23.8	NS
Beet yellows	18.6	19.5	19.6	19.2	NS
Beet & western yellows	17.1	19.1	18.4	18.2	1.31
LSD (5%) for treatments (average of all varieties)=1.34					
<u>Percent Sucrose</u>					
Check	12.8	12.2	13.1	12.7	0.65
Western yellows	12.2	11.9	12.7	12.2	0.50
Beet yellows	12.5	12.0	12.9	12.5	NS
Beet & western yellows	11.6	11.3	11.8	11.6	NS
LSD (5%) for treatments (average of all varieties)=0.47					

In the second test the combination of beet and western yellows caused root-yield losses ranging from 21.0 to 49.5 percent (table 3). The selection 213 showed approximately two-thirds as great a loss as did the US 75 variety from which it was selected. The loss in both root yield and sucrose percentage was significantly lower in the selection. The loss in the best selection from 671 was also significantly reduced by approximately one-third over that of the parent line. A selection from the 663 top cross parent failed to show any improvement in yellows resistance. A tetraploid from 663 showed significantly less damage than did the diploid form.

Two of the most promising selections developed by the Instituut voor Rationele Suikerproductie in The Netherlands were included in the test. One of these selections, 235, proved inferior to selections made at Salinas. The second selection, 234, was outstanding in this test and showed a significantly lower yield loss than any of the USDA selections tested. The performance of inoculated check of 234 was also comparable to that of US 75.

The six hybrid varieties evaluated for resistance to the combination of beet and western yellows showed yield losses of about 40 percent and a reduction in sucrose content of 1.21 to 1.86 percentage points (table 4). No significant differences were observed among hybrids. Triploids were no more resistant than were diploid forms of the same hybrids.

Root yield losses from western yellows among seven F₁ male-sterile hybrids ranged from 12.8 to 22.7 percent (table 5). Losses in sucrose content ranged from 0.68 to 1.24 percent, but differences among hybrids were not significant.

Damage from western yellows varied widely among the inbred lines, but the differences were not significant (table 5). Stands were more irregular in the inbreds and root rot caused damage in several of the lines.

Table 3. Reduction in yield and sucrose percentage of yellows-resistant selections and of unselected lines when inoculated with a combination of beet and western yellows viruses at Davis, California, in 1963.

Variety	Description	Performance of Check			Loss from Yellows		
		Root Yield	Sucrose	Percent	Root Yield	Sucrose	Percentage Points
		Tons/Acre	Percent		Percent	Percentage	
011	4th suc. yel. res. sel. US 75	27.6	13.5		37.9	1.22	
213	5th suc. yel. res. sel. US 75	26.5	13.1		30.3	1.08	
230	5th suc. yel. res. sel. US 75	27.2	13.7		35.9	1.15	
368	US 75	27.3	13.6		49.5	1.85	
221	2nd suc. yel. res. sel. 671	26.5	13.8		29.8	1.90	
231	2nd suc. yel. res. sel. 671	24.2	13.2		41.1	1.83	
671	Type 0 line	27.0	13.7		45.9	1.67	
233	1st yel. res. sel. 663	31.2	13.4		45.7	1.35	
663	Top cross parent	29.6	13.5		42.5	1.26	
F62-63T	663 (tetra)	29.7	13.1		32.5	1.30	
219	Yel. res. sel. 55-RF393	25.2	12.9		38.0	1.46	
234	Yel. res. sel. from Rietberg	28.2	13.5		21.0	0.47	
235	Yel. res. sel. from Rietberg	28.7	14.5		41.3	1.92	
LSD (5%)		0.90	0.63		5.6	0.73	

Table 4. Reduction in yield and sucrose percentage of hybrid sugarbeet varieties when inoculated with a combination of beet and western yellows viruses at Davis, California, in 1963.

Variety	Description	Performance of Check		Loss from Yellows	
		Root Yield Tons/Acre	Sucrose Percent	Root Yield Percent	Sucrose Percentage Points
163H2	US H6	27.9	14.5	39.0	1.86
263TH4	(562 x 569) x 663(4n)	28.7	13.8	40.5	1.31
2539H1	(515 x 569) x NB7	26.5	13.9	41.3	1.45
2539H4	(562 x 569) x NB7	25.2	13.7	41.4	1.21
263TH2	US H6 (triploid)	31.4	13.5	41.8	1.28
263H4	(562 x 569) x 663(2n)	29.0	14.2	42.0	1.48
LSD (5%)		1.86	0.62	NS	NS

Table 5. Reduction in yield and sucrose percentage of sugarbeet varieties and inbreds when inoculated with western yellows virus at Davis, California, in 1963.

Varieties and Hybrids	Description	Reduction in	Reduction
		Root Yield	in Sucrose
		<u>Percent</u>	<u>Percentage</u>
			<u>Points</u>
509H1	NB1 x NB3	12.8	0.90
547H1	NB1 x NB5	14.8	1.08
569H3	562 x 569	16.5	0.68
546H1	562 x 546	17.5	1.02
554H1	NB1 x NB4	18.3	0.88
511H1	NB1 x NB2	18.5	1.24
952	Type 0 US 15	19.2	0.76
569H1	515 x 569	22.7	0.92
LSD (5%)		7.4	NS
<u>Inbreds</u>			
554	NB4	0.0	0.62
502H0	MS of NB1	12.6	0.64
511	NB2	14.8	0.72
546	mm inbred	18.3	0.86
2750	M- inbred	21.6	1.60
539	NB7	21.7	0.80
549	mm inbred	24.3	0.66
569	mm inbred	28.5	1.16
LSD (5%)		NS	NS

Discussion and Conclusions

The 1963 yellows-resistance evaluation tests were among the best that have been conducted by the U.S. Agricultural Research Station. Excellent infection in the inoculated plots and absence of infection in the check plots contributed to the success of the tests. Clear-cut differences in resistance to both beet yellows and western yellows were demonstrated.

Results with selections from US 75 and 671 clearly demonstrated that improvements in resistance can be made by selecting in the field on the basis of root size from plants inoculated with yellows. The improvement in resistance was expressed primarily as an improvement in root yield. A tendency for improved sucrose percentage was also observed in the US 75 selections, but the results were highly variable. The 1963 results provide additional evidence that the comparison of root yields of inoculated and noninoculated plots is a more reliable measure of resistance than is a comparison of sucrose percentages.

Losses from yellows were higher in 1963 tests at Davis than in similar 1962 tests. As an example, the 1962 root-yield losses in the 539H1 hybrid were 4.4 percent for western yellows, 24.2 percent for beet yellows, and 28.9 percent for the combination of beet and western yellows. In 1963, root-yield losses for 539H1 were 19.2 percent for western yellows, 34.7 percent for beet yellows, and 40.0 percent for the combination of viruses.

Differences in the relative resistance of 011, the fourth successive selection from US 75, have also been observed. In 1961, root-yield losses were 42 percent for US 75 and 24 percent for 011. In 1962, root-yield losses were 43 percent for US 75 and 29 percent for 011. In 1963, losses were 50 percent for US 75 and 38 percent for 011. The inoculations were made with a combination of the same strains of beet and western yellows viruses in each of the three years.

The results of the past three years show that the damage from yellows varies from season to season, even though inoculations are made with the same strains of virus on plants of approximately the same age. More than one year's testing is required to correctly assess the resistance of a variety or selection.

RESULTS OF 1963 FIELD TESTS OF F_2 AND F_3 SELECTIONS MADE
ON THE BASIS OF ROOT WEIGHT AND \bar{O} ON THE AMINO ACID PATTERN
IN INFECTED LEAVES FOR POSSIBLE RESISTANCE TO BEET YELLOWS

by

J. M. Fife

INTRODUCTION

The concentration of certain amino acids has been found to be greatly upset in the mature leaves of sugarbeet plants showing the chronic symptoms of beet yellows and western yellows 1/. The degree of upset in the amino acid pattern was found to vary over a wide range among individual plants, indicating that the degree of upset may be correlated with resistance. If this is the case, then the amino acid pattern may be an aid in identifying individual plants that are resistant to beet yellows and possibly to western yellows as well.

This report summarizes the 1963 field plot tests of the F_2 and the F_3 generations which were produced without making any further selection.

METHODS AND RESULTS

More than 1000 plants of US 75 were grown in sand culture in the greenhouse under controlled nutritional conditions. The plants were inoculated, in the 4-leaf stage, with a virulent strain of the beet yellows virus. Mature leaves, showing the chronic symptoms of the disease, were taken from each plant and the juice expressed. The expressed juice was analyzed, by paper chromatography, for certain amino acids. Individual plants were selected on the basis of the root weight, after 120 days of growth, and the amino acid ratio 2/, calculated from the concentration of three amino acids determined in the mature leaves taken earlier.

1/ Amer. Soc. Sugar Beet Tech. XI (4) 327-333.

2/ Amino acid ratio: $\frac{\text{Aspartic acid} + \text{Glutamic acid}}{\text{Citrulline} + \text{Alanine}}$. Evidence has recently been obtained to indicate that the amino acid called citrulline may, on further investigation, turn out to be another amino acid instead. This in no way affects the results. Until the identity of this particular amino acid is definitely established, the denominator of the above amino acid ratio should read, "Two amino acids" (calculated as Citrulline).

Twenty-eight plants, having a superior root weight and also an amino acid ratio greater than the mean, for all plants tested, were selected. These 28 plants were given 120 days of thermal induction and then placed in isolation for an open-pollinated seed increase. The seed from each plant was harvested separately, thereby making ⁷ each selection originating from a single plant progeny. Ten other plants, having a superior amino acid ratio and in addition a greater than the mean root weight were selected from the same 1000 plants. These plants were also given thermal induction and placed in isolation for an open-pollinated seed increase. The seed from each of these 10 plants was also harvested separately, thereby making each of these selections originating from a single plant progeny. A more complete description of the methods used has been reported 3/.

Screening tests were conducted in the greenhouse, on healthy and beet-yellows inoculated plants of the selections grown under controlled nutritional conditions. Those selections having a growth rate 4/ superior to that of the parent were tested in the field.

Seed increases (F_2) were made without further selection of certain lines that appeared promising. Seed increases (F_3) were again made without further selection.

In the tests conducted in 1963, one F_2 and four F_3 progeny of selections were tested along with the parent US 75.

The test was carried out adjacent to the regular planting of a plot test conducted by McFarlane, Bennett and Skoyen. The agronomic operations and cultural practices were the same, the only difference being in the experimental design. The information pertinent to this test is given below.

Location: Spence field of the U. S. Agricultural Research Station.

Soil type: Sandy loam.

Fertilizer applied: lbs. 10-10-5 preplant.

May 27, 1963, 200 lbs. ammonium sulfate.

July 2, 1963, 200 lbs. ammonium sulfate.

Planting date: April 8, 1963.

Thinning date: May 13, 1963.

Disease treatment: Plants inoculated June 26, with a virulent strain of the beet yellows virus.

3/ Foundation Project. Sugar Beet Research, 1961 Report, p. 295-318.

4/ Amer. Soc. Sugar Beet Tech. 12, (6) 497-502.

Harvest date: October 21, 1963.

Irrigation: Sprinkler irrigation as required up to May 15; subsequently, furrow irrigation used at about 10-day intervals until harvest.

Diseases and insects: By thinning time, practically 100 per cent of the plants were naturally infected with yellows viruses. Other diseases and insect injury were not factors in this test.

Experimental design: 6 X 6 latin square, two-row plots 50 feet long, rows 28 inches apart.

Sugar analysis: From two 20-beet samples taken from each plot and run in duplicate.

It is generally conceded that the 1963 season, in the Salinas Valley at least, was the second best year in history for sugarbeet production. Although the experimental plot was inoculated with the same strain of the beet yellows virus as the previous year, the degree of yellowing and the extent of necrosis was considerably less in the 1963 test. During the month before harvest, frequent rains and other favorable conditions stimulated new growth. At harvest, there was no marked difference in color between inoculated and uninoculated plants of the plot.

Despite the favorable season and the vigorous second growth occurring the last month, four of the five selections produced a greater tonnage of beets than did the parent, Table 1. These differences, however, were not found to be significant. One selection yielded 1.6 tons of beets more per acre than the parent. This same increase in tonnage over the parent was found for one selection in the 1962 tests, which was significant.

Two selections had a higher percentage sucrose than the parent. One selection was significantly greater than the parent at the 5 percent level.

The greater yield of beets of two selections, coupled with higher percentages of sucrose, produced significantly more sugar per acre than the parent.

Certain sugarbeet selections, made on the basis of a combination of the root weight and on the amino acid pattern in mature infected leaves, are superior to the parent in yield of sugar per acre. These results are in accord with observations made in the two preceding years.

Table 1.

Field test of selections ^{1/} inoculated in an early stage of growth with a virulent strain of beet yellows virus, 1963.

Selection	Gen.	Acre Yield		Sucrose Percent	Harvest Count Number
		Sugar Pounds	Beets Tons		
US 75		3633	13.9	13.1	140
DS-3	F ₃	4163 ^a	15.0	13.9 ^a	137
DS-9	F ₃	3418	13.8	12.3	145
DS-22	F ₃	3708	14.9	12.3	148
DS-23	F ₃	4077 ^a	14.9	13.6	152
DS-C	F ₃	3958	15.5	12.7	146

^{1/} Selections made on the basis of a superior root weight and a greater than the mean amino acid ratio.

"a" Superscript: Superior to the parent when applying Duncan's multiple range test.

General MEAN	3826	14.7	13.0	144
S. E. of MEAN	137	0.49	0.26	Beets
L.S.D. (19:1)	400		0.76	per
S. E. of MEAN				100'
in % of MEAN	3.6	3.3	2.0	row

Odds 19:1 = $2.060 \times \sqrt{2}$ x Standard Error of MEAN

VARIANCE TABLE

Variation due to	Degrees of Freedom	M E A N S Q U A R E S		
		Sugar Pounds	Tons Beets	Percent Sucrose
Between selections	5	493,968	2.72	2.53
Between replications	5	901,611	10.43	0.26
Remainder (Error)	25	113,440	1.44	0.42

Total

35

Calculated F value

4.35** N.S.

4.11**

** Exceeds the 1% point of significance (F=3.68)

P A R T XI

RHIZOCTONIA INVESTIGATIONS

Selecting for Resistance and Utilization
of Inoculation Techniques

Foundation Project 25

J. O. Gaskill

Research conducted in cooperation with the Botany and Plant
Pathology Section, Colorado Agricultural Experiment Station.

RHIZOCTONIA INVESTIGATIONS, FORT COLLINS, COLORADO, 1963 1/

(A phase of Beet Sugar Development Foundation Project 25)

John O. Gaskill

A study of Rhizoctonia exposure techniques for evaluation of resistance in sugarbeet lines under field conditions (Experiment R-1) was the principal undertaking in Rhizoctonia research at Ft. Collins in 1963. Field work on Rhizoctonia also included preliminary trials of other exposure techniques, selection of roots under disease conditions for breeding purposes, production of seed, and preliminary evaluation of resistance of a number of breeding lines. The latter phase included lines resulting from Rhizoctonia resistance selection work performed independently by the U. S. Department of Agriculture and the Great Western Sugar Company. This report pertains to Experiment R-1, only.

Material and Methods

The sugarbeet varieties or strains used in this study are described below:

<u>Strain</u> <u>no.</u>	<u>Ft. Collins</u> <u>seed no.</u>	<u>Description</u>
1	Acc. 2233	SP 5831-0; a monogerm, U.S.D.A. variety, resistant to leaf spot and black root.
2	SP 621004-0	A product of selecting for Rhizoctonia resistance, at Ft. Collins, in SP 5831-0.
3	Acc. 2168	GW 674-56C; a multigerm, G.W.S. Co., leaf spot resistant variety.
4	SP 621113-00	Increase of SP 611107-0; a product of selecting for Rhizoctonia resistance, at Ft. Collins, in GW 674-56C.
5	Acc. 2518	C 817 (G.W.S. Co.); an increase of LeRoy Powers' Select A54-1 Synthetic; multi-germ; leaf spot resistant; derived from GW 359.

1/ A progress report on investigations conducted by the Crops Research Division, Agricultural Research Service, U.S. Department of Agriculture, in Cooperation with the Colorado Agricultural Experiment Station, the Beet Sugar Development Foundation, and the Board of County Commissioners of Larimer County.

- | | | |
|---|-------------|--|
| 6 | SP 621003-0 | A product of selecting for Rhizoctonia resistance, at Ft. Collins, in C 817. |
| 7 | Acc. 2057 | US 401; multigerm, U.S.D.A. variety, resistant to leaf spot and black root. |

Inoculation techniques and timing were as follows:

<u>Treat. no.</u>	<u>Description</u>
1	Semi-circle method, early (July 15, 1 week after thinning)
2	Rosette method, early (July 15, 1 week after thinning)
3	Semi-circle method, late (July 29, 3 weeks after thinning)
4	Rosette method, late (July 29, 3 weeks after thinning)

Dry, ground, barley-grain inoculum of a highly pathogenic isolate of Rhizoctonia (B-6) was used at the rate of one-sixth teaspoon per plant. The term, semi-circle method, signifies the placement of inoculum in a half circle about 1 1/2 inches from the tap root and 1 inch below the soil surface. In the other method, inoculum was deposited in the center of the foliar rosette.

A high-fertility field, in which barley had been grown in 1961 and 1962, was used for this study. The experiment was arranged in 2 distinct halves separated by a 30' fallowed strip. The entire field was irrigated by sprinkler as needed for satisfactory plant growth throughout the season and to maintain a relatively moist condition at the inoculum sites for a few days after the application of inoculum. In addition, the west half of the experimental area -- designated the "high moisture" section -- was given supplemental water from July 26 to the end of the irrigating season (September 19). Ordinarily this was done by means of one moderate supplemental sprinkling in each interval between the regular irrigation sprinklings for the entire field. During the period, July 26 through September 19, the west half of the field received about 61 percent more hours of artificial sprinkling than the east half. Natural precipitation during the period amounted to approximately 2.6 inches, most of which fell after August 24. A heavy rain fell on September 20.

Within each half of the experiment (see above), inoculation treatments occurred as main plots with 2 replications. The 7 sugarbeet strains occurred in 7 subplots within each main plot. Thus, in the entire experiment, each sugarbeet strain occurred in 16 subplots. Each subplot was

2 rows x 25' in size, with rows 20" apart. An area, 2 rows x 14', was inoculated in each plot. The entire experiment was planted on June 10 and thinned (about 9" spacing) on July 8. Harvest, performed on October 14, was limited to the inoculated section of each subplot. All living plants were trimmed (leaves and petioles removed), washed, and weighed. Living plants were counted in the inoculated section of each subplot periodically between the dates of thinning and harvest, and survival percentages were based on thinned stand. Variance analyses were omitted where variation was seriously restricted by the frequent occurrence of zero subplot values.

Results and Discussion

As shown in Figure 1 and Table 1, inoculations performed on July 15, 1 week after thinning, resulted in prompt and extremely severe attack. Some early evidence of differences in resistance among sugarbeet strains had largely disappeared by August 27, approximately 6 weeks after inoculation, when all but 0.3 percent of the population were dead. At harvest (October 14) only 1 inoculated plant remained alive in the entire set of 56 subplots.

Rhizoctonia attack, resulting from inoculations made on July 29, 3 weeks after thinning, was much slower than that resulting from the earlier inoculations. As shown in Figure 2 and Table 2, sugarbeet strains differed very strikingly in percentage survival from 4 to 7 weeks after the July 29th inoculations. By harvest, however, the average percentage survival had dropped to 4.5 (Table 2), and the yield of roots (Table 3) averaged 1.12 pounds per subplot. Actual differences among strains at that time were small, but on a relative basis these differences appeared to be rather substantial.

Features of special interest in Tables 2 and 3 are the systematically higher average survival percentages and higher average yields shown for the selections (strains 2, 4, and 6) as compared with the corresponding parental varieties (strains 1, 3, and 5, respectively). On August 27, the average survival of the 3 selections was 187 percent of that of the parents. Corresponding percentages on September 16 and October 14 were 283 and 235, respectively. Root yields of the 3 selections averaged 214 percent of that of the parents. It also is noteworthy that the higher average survival percentage and higher average root yield shown for strain 4 (increase of SP 611107-0), in contrast with the parental variety, strain 3 (GW 674-56C), and the check, strain 7 (US 401), are in keeping with results reported for those strains in experiments conducted in 1961 and 1962.

Comparative reaction to the 2 inoculation methods, as shown in Table 1, is of little importance, because of the extreme severity of disease attack resulting from the July 15th inoculations. Where variance analyses

Table 1. -- Comparative survival percentages of sugarbeet strains following Rhizoctonia inoculations performed on July 15, 1963, 1 week after thinning. Basic results presented as 2-plot averages

Date	Strain no.	High moisture ^{a/}			Low moisture			Average, high and low moisture		
		Treat. : 1	Treat. : 2	Aver. : 1 & 2	Treat. : 1	Treat. : 2	Aver. : 1 & 2	Treat. : 1	Treat. : 2	Aver. : 1 & 2
7/31	1	20.5	4.0	12.2	37.7	8.4	23.0	29.1	6.2	17.6
	2	27.0	13.1	20.0	25.6	10.3	18.0	26.3	11.7	19.0
	3	33.9	5.0	19.4	28.2	1.4	14.8	31.0	3.2	17.1
	4	45.4	10.8	28.1	46.6	18.6	32.6	46.0	14.7	30.3
	5	23.2	2.7	12.9	35.1	5.0	20.0	29.1	3.8	16.5
	6	44.5	24.0	34.3	27.8	8.3	18.0	36.1	16.1	26.1
	7	31.7	7.7	19.7	23.5	2.5	13.0	27.6	5.1	16.3
Average		32.3	9.6	20.9	32.1	7.8	19.9	32.2	8.7	20.4
LSD (.05)		17.9								
F (strains)		1.84								
F (interaction, strains x treat.)		0.38								
8/27	1	0.0	0.0	0.0	2.5	0.0	1.3	1.3	0.0	0.6
	2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	3	0.0	0.0	0.0	0.0	1.4	0.7	0.0	0.7	0.3
	4	1.4	1.3	1.3	0.0	0.0	0.0	0.7	0.7	0.7
	5	0.0	0.0	0.0	1.3	0.0	0.7	0.7	0.0	0.3
	6	0.0	1.3	0.7	0.0	0.0	0.0	0.0	0.7	0.3
	7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Average		0.2	0.4	0.3	0.5	0.2	0.4	0.4	0.3	0.3

^{a/} The high-moisture condition was begun on 7/26/63.

^{b/} Average of treatments 1 and 2 for the indicated strain (a product of selection for Rhizoctonia resistance) expressed as percent of the average for the corresponding parental variety.

Table 2. — Comparative survival percentages of sugarbeet strains following Rhizoctonia inoculations performed on July 29, 1963, 3 weeks after thinning. Basic results presented as 2-plot averages.

Date	Strain no.	High moisture			Low moisture			Average, high and low moisture		
		Treat. : 3	Treat. : 4	Aver. : 3 & 4	Treat. : 3	Treat. : 4	Aver. : 3 & 4	Treat. : 3	Treat. : 4	Aver. : 3 & 4
8/27	1	35.4	46.9	41.2	8.4	22.6	15.5	21.9	34.8	28.3
	2	50.4	68.4	59.4	6.3	54.6	30.4	28.3	61.5	44.9
	3	32.4	32.9	32.7	6.7	16.7	11.7	19.6	24.8	22.2
	4	52.8	75.8	64.3	24.9	44.8	34.9	38.9	60.3	49.6
	5	50.6	52.1	51.4	9.5	32.6	21.0	30.0	42.3	36.2
	6	64.9	87.5	76.2	52.1	54.2	53.1	58.5	70.9	64.7
	7	28.2	29.3	28.7	7.9	13.6	10.8	18.0	21.5	19.7
Average		45.0	56.1	50.5	16.5	34.2	25.3	30.7	45.1	37.9
LSD (.05)				18.3			15.8			
F (strains)				8.52**			8.95**			
F (interaction, strains x treat.)				0.73			2.28			
9/16	1	2.6	14.9	8.7	0.0	2.5	1.2	1.3	8.7	5.0
	2	7.5	31.6	19.6	0.0	16.6	8.3	3.8	24.1	13.9
	3	2.6	7.6	5.1	0.0	1.3	0.7	1.3	4.5	2.9
	4	9.5	25.8	17.6	1.3	6.8	4.0	5.4	16.3	10.8
	5	9.3	21.4	15.4	0.0	6.6	3.3	4.7	14.0	9.3
	6	18.5	38.0	28.3	2.7	15.3	9.0	10.6	26.7	18.6
	7	0.0	9.3	4.7	0.0	1.2	0.6	0.0	5.3	2.6
Average		7.1	21.2	14.2	0.6	7.2	3.9	3.8	14.2	9.0
LSD (.05)				9.2						
F (strains)				8.20**						
F (interaction, strains x treat.)				1.14						
10/14	1	2.6	8.7	5.6	0.0	0.0	0.0	1.3	4.4	2.8
	2	3.8	17.1	10.4	0.0	8.3	4.1	1.9	12.7	7.3
	3	1.3	5.1	3.2	0.0	1.3	0.7	0.7	3.2	1.9
	4	8.1	11.5	9.8	0.0	4.1	2.0	4.1	7.8	5.9
	5	2.7	16.1	9.4	0.0	2.6	1.3	1.4	9.3	5.3
	6	2.9	18.4	10.6	0.0	7.0	3.5	1.4	12.7	7.1
	7	0.0	4.0	2.0	0.0	1.2	0.6	0.0	2.6	1.3
Average		3.0	11.5	7.3	0.0	3.5	1.7	1.5	7.5	4.5

a/ Average of treatments 3 and 4 for the indicated strain (a product of selection for Rhizoctonia resistance) expressed as percent of the average for the corresponding parental variety.

Table 3. -- Comparative root yields of sugarbeet strains following Rhizoctonia inoculations performed on July 29, 1963, 3 weeks after thinning. Basic results presented as pounds per plot (2-plot averages). ^{a/}

Strain: no. :	High moisture			Low moisture			Average, high & low moisture			:
	Treat.: 3 :	Treat.: 4 :	Aver.: 3 & 4 :	Treat.: 3 :	Treat.: 4 :	Aver.: 3 & 4 :	Treat.: 3 :	Treat.: 4 :	Aver.: 3 & 4 :	
1	0.36	3.45	1.90	0.00	0.00	0.00	0.18	1.72	0.95	
2	0.47	3.96	2.22	0.00	1.08	0.54	0.24	2.52	1.38	145
3	0.16	1.22	0.69	0.00	0.21	0.10	0.08	0.71	0.40	
4	0.68	3.83	2.25	0.00	1.13	0.57	0.34	2.48	1.41	353
5	0.44	4.25	2.35	0.00	0.61	0.31	0.22	2.43	1.33	
6	0.73	3.78	2.25	0.00	3.14	1.57	0.36	3.46	1.91	144
7	0.00	0.66	0.33	0.00	1.30	0.65	0.00	0.98	0.49	
Average	0.40	3.02	1.71	0.00	1.07	0.53	0.20	2.04	1.12	214

^{a/} 28 ft. of row per plot; 10/14/63

^{b/} Average of treatments 3 and 4 for the indicated strain (a product of selection for Rhizoctonia resistance) expressed as percent of the average for the corresponding parental variety.

were performed for the data summarized in Table 2, the interaction, strains x treatments, was not significant. On this basis it would appear that relatively similar results could be expected from the 2 methods (treatments 3 and 4). However, since disease attack was slower and final survival percentages were higher for treatment 4 than for treatment 3, the former would seem to be preferable. Furthermore, treatment 4 -- the rosette method -- has the additional advantage of convenience.

Since moisture levels were not replicated, the differences between moisture levels must be considered inconclusive. However, the higher survival percentages shown in Table 2 for the higher moisture level suggest that such conditions may be more favorable for Rhizoctonia-resistance evaluation work.

Conclusions

1. Inoculations performed 3 weeks after thinning appeared to be more favorable for Rhizoctonia-resistance evaluation of sugarbeet strains than inoculations performed 1 week after thinning.
2. The rosette inoculation method was at least as effective as the semi-circle method -- perhaps more so -- for resistance evaluation purposes where inoculations were performed 3 weeks after thinning.
3. The use of relatively high soil moisture conditions may be more desirable for resistance evaluation work. Further study of this question is needed.
4. Where inoculations were performed 3 weeks after thinning, there were highly significant differences among sugarbeet strains, in percentage survival, 4 to 7 weeks after inoculation. During that period, a strong tendency toward higher survival percentages was evident for lines derived by selection for Rhizoctonia resistance as contrasted with their parental varieties. These observations indicated the existence of a measurable degree of resistance in the 3 selections, as a class. However, this level of resistance was not sufficient to maintain a large actual yield advantage at harvest under the conditions of this experiment.



Figure 1. -- General view of Rhizoctonia experimental field, Ft. Collins, Colo., September 3, 1963. Complete kill by treatment 2 is shown in foreground where inoculation was performed on July 15, 1 week after thinning.

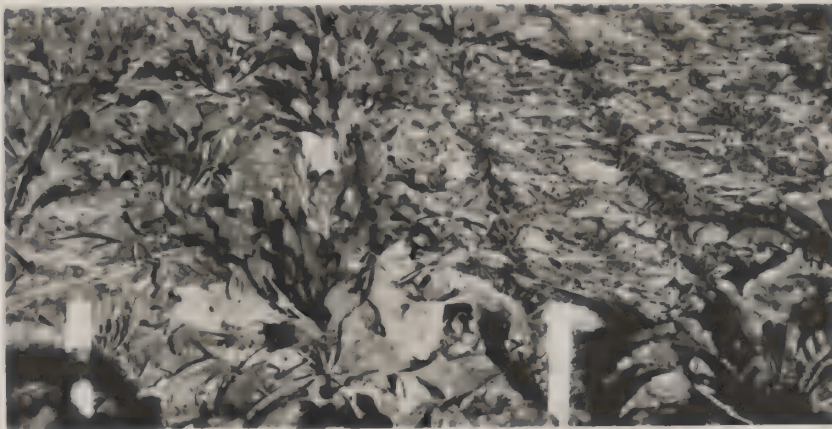


Figure 2. -- Comparative reaction of 2 sugar-beet strains to Rhizoctonia, Ft. Collins, Colo., September 3, 1963. Inoculation (treatment 4) was performed on July 29, 3 weeks after thinning. Two-row plots, left to right: strain 2 (selection from SP 5831-0), and strain 7 (US 401).

P A R T XII

CERCOSPORA LEAF SPOT INVESTIGATIONS

Lucas Calpouzos

Research conducted in cooperation with Minnesota
Agricultural Experiment Station.

CERCOSPORA LEAF SPOT INVESTIGATIONS^{1/}

L. Calpouzos

A research program was started in 1963 to study fundamental and applied aspects of sugarbeet diseases. Cercospora leaf spot has become in recent years a major disease problem of sugarbeets in the North Central United States. This disease is currently being studied and some of the initial results are reported here.

Sporulation of the Pathogen in Culture

Most cercospora species including *C. beticola* sporulate poorly or not at all in culture. Since the early part of this century researchers have attempted to induce cultures of *C. beticola* to form large quantities of spores to be used as a source of artificial inoculum. Varying degrees of success were reported and were often attributed to the use of certain media whose identity commonly differed from one report to another. Special techniques were also recommended, such as working with cultures of a certain age, using conidia rather than mycelium when preparing new transfers, mechanically injuring mature colonies, or transferring mature colonies to fresh medium. Although spores were sometimes obtained in culture, a clear understanding of the factors controlling sporulation is lacking. These factors are being investigated and current data are summarized here.

General Materials and Methods. Eight isolates of *C. beticola* were used, of which designations and origins are as follows: "Iowa" from N.E. Iowa, "RRV" from Eastern North Dakota in the Red River Valley, "Rose" from Central Minnesota, "NR" from Southern Minnesota, "Ohio" from N.E. Ohio, "Holland" from S.W. Netherlands, "Bav" from S.W. Germany, and "Italy" from Northern Italy. The Bav, Holland, Ohio, and Iowa were single-spore isolates; however, no differences in fungal behavior could be attributed to the fact that some isolates were single-spore and the others were not.

Sporulation was determined by observing the fungus colonies under a dissecting microscope at a magnification of 18 and 72X. The sporulating region of a colony often appeared as a dark olive-gray area consisting of erect, nonbranching growth, whereas the sterile region varied from white to dark gray, primarily with either short or long flaccid, branched hyphae. Presence of spores was checked by removing a 2-3 mm² piece of the colony, using an arrow-pointed needle and gently touching the aerial

^{1/} In cooperation with the Department of Plant Pathology and Physiology, and the Agricultural Experiment Station, University of Minnesota.

growth to the agar surface. Spores, if present, detached readily and were easily observed lying on the agar. Hyphae were rarely detached by this treatment. The ratio of sterile hyphae to sporulating growth was rated according to an arbitrary scale of 0-5, where 5 indicates that only sporulating growth is present. This method of estimating sporulation is quick, it provides a measure of local variations in sporulation which can be great within a single colony, and it leaves the colony largely undisturbed for future observations.

Importance of Fungus Strains for Sporulation. The 8 isolates were subcultured approximately every 7 days over a period of 2 to 4 months on a single nutrient medium, Mycophil agar^{2/}, which provided luxuriant growth. Before transferring, the colonies were examined microscopically. Morphologically distinct sectors were common within each colony. Some sectors contained few to many spores, while most sectors consisted only of sterile hyphae. Inoculum for the new subculture was selected from sporulating areas, if present. During this experiment sporulating colonies would occasionally form sterile sectors, and conversely, sterile colonies would form sectors bearing spores. Generally, sporulating areas were more common on colonies less than one-week old. After several successive subcultures, the NR, Rose and Holland isolates gave rise to strains which sporulated regularly on 10-60% of the surface area of one-week-old colonies. The other isolates were erratic in their sporulating behavior, except for Bav which remained sterile. These results suggest that sporulation is influenced by the genetic nature of the fungus. Strains must be selected that have the inherent capacity to sporulate. However, this is not the only important factor, as will be shown by the next experiment.

Importance of Media for Sporulation. All eight isolates, after being subcultured as described above, were grown on several synthetic and natural media, each containing from 1.5-2% agar. Water agar (WA)—distilled water plus 2% of pure agar. Czapek Dox agar (Cz)—35g of commercially prepared Czapek Dox broth plus 20 g of agar per liter of water. Potato dextrose agar (PDA)—39g of commercially prepared medium per liter of water. Mycophil agar (MYC)—40g of commercially prepared medium per liter of water. V8-Juice agar (V8)—250 ml of commercial V8 juice made up to one liter with water and 20g of agar added. (V8 + S)—same as V8 but with 20g of glucose. Sugarbeet leaf extract agar (BLA)—250g of chopped fresh sugarbeet leaves boiled for 15 minutes in 750 ml of water which was then decanted and diluted to one liter and 15 20g of agar added. (BLA + S)—same as BLA but with 20g of glucose. The media were autoclaved and poured uniformly in Petri dishes to a depth of approximately 5 mm. The pH of each fresh medium was measured. Each isolate was inoculated uniformly with the same source of inoculum on each of the agar plates. All plates were incubated under the same temperature, humidity, and light conditions. Amount of sporulation was observed

^{2/} A papaic digest of soy meal, plus glucose. Prepared by the Baltimore Biological Laboratories, Baltimore, Md.

six days after inoculation. The pH of the medium directly under the colony was also measured at six days. The results summarized in Table 1 show that sporulation can vary widely for a given isolate grown on different media. BLA and BLA + S media favored the greatest amount of sporulation on the average. Colonial growth (not shown in Table 1) was greatest on MYC and the two V8 media, while PDA, Cz, and the two BLA media had slightly less but still considerable growth. WA supported only a trace of growth. The nature of the medium, therefore, is another important factor affecting sporulation of Cercospora beticola in culture. This effect probably is not due to pH, since no correlation exists in Table 1 between pH and sporulation. These studies are continuing.

Effect of Early and Late Planting on Leaf Spot Incidence

Growers often claim that late-planted sugarbeets, as contrasted to early-planted, develop less leaf spot. A preliminary experiment was carried out, first to confirm the effect of early and late planting dates, and second, to explore the reason for this phenomenon.

The experiment was conducted at the Agricultural Experiment Station of the University of Minnesota, in Rosemount, on a rectangular field 37 x 80 feet. Twenty 80-foot rows each spaced 22 inches apart were marked out. Alternate sets of 4 rows; nos. 1-4, 9-12, and 17-20, were planted to variety American Crystal 3N on May 8, 1963. Five weeks later, June 14, the remaining rows, nos. 5-8 and 13-16, were also planted to variety 3N. This design provided two plots of late-planted beets bordered on either side with plots of early-planted beets.

On July 13, nine weeks after the first planting, no disease had appeared; therefore, the plots were inoculated thoroughly with a water suspension of pulverized old diseased leaves by means of a motorized mist blower. A week later, about 200 heavily diseased fresh leaves obtained elsewhere were scattered uniformly throughout the plots as an additional source of inoculum.

Leaf spot symptoms first appeared in August and observations were made on August 30, September 6 and 30; 16, 17 and 20 weeks, respectively, after the first planting. Disease was uniformly distributed within each plot. The average amount of disease in a plot was determined by rating twelve randomly selected plants located about halfway along the 80-foot axis of the field. The disease-rating scale ranged from 0-5 according to the Kleinwanzlebener Cercospora-table.

The data were analyzed statistically by the F test, and are summarized in Table 2. The August 30 and September 6 results indicated that the early-planted beets had more disease (at the 1% level of significance) than the late-planted beets. The data taken on September 30 showed no significant difference in the amount of disease between early- and late-planted beets.

Table 1. Sporulation of *Cercospora beticola* isolates on different media six days after inoculation, and the pH of the media.

Cercospora isolate	BLA(5.9)	BLA+S(5.8)	Media (and initial pH) V8(4.4)	V8+S(4.5)	MYC(6.3)	PDA(5.4)	CZ(6.8)	WA(7.4)
NR	5 ^a (8.2) ^b	4.5 (7.1)	4.5 (8.4)	4 (6.7)	1 (7.0)	3 (6.7)	2 (8.3)	0.5(6.5)
RRV	2.5 (8.5)	4 (7.8)	1 (8.4)	0 (7.8)	0 (7.2)	0 (6.5)	0 (8.0)	0 (6.6)
Rose	3.5 (8.3)	2 (7.3)	3.5 (8.3)	3.5(6.4)	3 (7.0)	2 (6.8)	2 (7.8)	0 (6.8)
Iowa	4 (8.6)	1 (7.2)	0.5 (8.5)	1 (6.3)	0 (7.5)	0 (6.5)	0 (8.0)	0 (6.5)
Ohio	1 (8.6)	0.5 (7.2)	0 (8.2)	0 (6.5)	0 (7.5)	0 (6.6)	0 (8.0)	0 (6.6)
Holland	-- ^{cd}	4.5 (7.6)	2 (7.5)	0 (6.4)	2 (8.0)	0 (6.8)	0 (8.4)	0 (7.0)
Italy	-- ^d	4.5 (7.3)	1 (7.5)	1.5(6.2)	0 (7.2)	0 (7.0)	0 (8.5)	0.5(7.0)
Bav	-- ^d	-- ^d	0 (8.5)	0 (5.9)	0 (6.4)	0 (3.5)	0 (9.0)	0 (7.0)
Average sporulation rating for all isolates	3.2	3.0	1.6	1.3	0.8	0.6	0.5	0.1

^a Sporulation rating: 0 = no spores, 5 = 100% of the colony surface had spores, no sterile growth.

^b Numbers in parenthesis indicate pH of medium under the 6-day-old colony. The media were unbuffered.

^c A dash indicates no agar plate available for this experiment.

^d In a further test, Bav did not sporulate on BLA or BLA+S whereas Holland and Italy had 4-5 sporulation.

Table 2. Average leaf spot rating on early- and late-planted sugarbeets observed on three different dates.^a

Observation date	Average leaf spot rating		F-test for significant difference ^d
	Early planted ^b	Late planted ^c	
August 30	1.7 ^e	1.1	**
September 6	1.7	0.8	**
September 30	4.9	4.8	NS

^a Inoculated on July 13 and 20, 1963.

^b Planted May 8. Average for 36 plants (12 per replicate plot), except on August 30 when only 2 plots were rated.

^c Planted June 14. Average for 24 plants (12 per replicate plot).

^d ** = difference between the 2 averages is significant at the 1% level.

^e Disease rating; 0 = no disease, 5 = whole plant diseased, outer leaves dead, inner leaves severely damaged, fresh foliage begins to grow.

Several possibilities could account for the difference in disease incidence at the first two observation dates. First, the microclimate among the older plants might have been more favorable for disease. It should be noted that the average plant size and density of foliage differed between the two groups of beets at the first two observations but not at the last. Second, the younger plants might have been producing new leaves more rapidly than the older plants. This could result in fewer diseased leaves of the total present on younger plants, hence a lower disease rating. Third, the younger beets at first might have been less susceptible to leaf spot, but with further growth (and perhaps with further increase in the inoculum load) the difference in susceptibility disappeared.

The results of this preliminary test support the notion that on late-planted beets leaf spot tends to develop more slowly than on early beets; however, the practical significance of this effect may not be important, since differences in disease levels tend to disappear with time. The reason for the temporary difference in disease between early- and late-planted beets is not known and deserves further study.

Dissemination of the Pathogen

It is commonly believed that the leaf spot fungus, Cercospora beticola, is disseminated primarily by wind; however, there are scant published data on the subject. Some field observations suggest that agents other than wind may also be important. For example, it is not unusual during the first stages of an epiphytotic to find: a) disease appearing in local areas of a field and spreading outwards gradually, or b) adjacent beet fields separated by a narrow roadway with one field showing significantly more disease than the other. If wind dissemination is the primary mode, one would expect a quicker and more uniform spread of disease throughout the beet fields.

Spore dissemination was studied during August and September at New Richland^{3/} and Rosemount^{4/}, Minnesota, where spore trap and weather data were collected for periods of 12 to 18 days. Two observation stations, one in the center of the sugarbeet field and the other 100 feet East of the field (westerly winds prevailed) were established on each farm. Three spore traps at 2-, 4-, and 7-feet, respectively, above the ground level were located at each station. The traps were exposed for 24-hour periods except for weekends when they were exposed for 2 or 3 days. Daily rainfall and wind speeds were obtained from weather stations 12 miles from the New Richland farm and one-half mile from the Rosemount farm. Periodic estimates of the spore population on the heavily diseased beet leaves were also made.

^{3/} The farm of Mr. G. Arneman.

^{4/} Agricultural Experiment Station Farm of the University of Minnesota.

The spore trap^{5/} consisted of a 6-inch glass rod with a polyethylene plastic strip, 1 x 2 cm, coated with silicone grease and wrapped around the rod near its upper tip. The rod was exposed by mounting it on top of a metal tube. Before and after exposure the rod was kept in a large, clean test tube in such a way as not to allow the plastic strip to touch the sides of the tube. Later, the plastic strip was removed from the rod, mounted on a glass slide and examined microscopically at 100X magnification. The entire length of the strip was scanned over a width of three microscopic fields. *Cercospora* spores were counted as well as other large fungus spores present. Small fungus spores were not counted.

Great numbers of *C. beticola* spores were present in both fields during the experiment. The New Richland sugarbeet field had a disease rating of 4-5 according to the Kleinwanzlebner *Cercospora*-table which ranges from 0 to 5. Leaves collected at the start, middle, and end of the experiment showed heavy sporulation on over 90% of the lesions. An estimate of over half a million spores per plant would be conservative. The Rosemount sugarbeet field had a disease rating of 3-5 during the experiment. Diseased leaves collected each week day showed heavy sporulation on 50-100% of the lesions. The inoculum potential was high.

Conditions favorable for wind dispersion were present during most of the experiment at each site. This was indicated by the wind speed data obtained from the weather stations and by the several hundred trapped large spores of other fungus species known to be wind disseminated, e.g. rusts and *Alternaria* spp.

The spore-trap results from the two farms and selected weather data are summarized in Tables 3A and 3B. Appreciable numbers of cercospora spores (100 or more per trap) were caught only during 5 out of 12 days in New Richland, and no days out of a possible 18 at Rosemount. By contrast, appreciable numbers of other large, wind-disseminated, fungus spores were trapped in at least 7 out of 8 days in New Richland and 7 out of 9 days in Rosemount (omitting weekends for the other-fungus-spore data). There is a trend for the numbers of spores to increase with increasing elevation of the trap. This could be due to eddy air currents and to more air flowing past the taller trap, since it is more exposed to the wind. In the New Richland data there is a trend for appreciable catches of cercospora to be associated with rainy days. This suggests that water may be involved in spore dispersal. The association between rainy days and trapped cercospora spores does not appear in the Rosemount data. This might be due to periods of little or no wind at the time of rainfall.

The spore trap data do not support the idea that *C. beticola* is primarily disseminated by wind, since large numbers of spores were present on the leaves near the traps as well as conditions favorable for wind dissemination, yet few spores were trapped except on some (not all) rainy days.

^{5/} Obtained from Dr. J. B. Rowell, Cooperative Cereal Rust Laboratory, University of Minnesota.

Table 3A. Number of cercospora spores and other large fungus spores trapped in and near a sugarbeet field at New Richland, Minnesota.

Trap collection date ^b	Station no. 1 ^c			Station no. 2 ^d			Rainfall inches	Wind speed daily ave M/H
	2 ft	4 ft	7 ft	2 ft	4 ft	7 ft		
Aug 2	100(219)	0(5)	345(663)	3(180)	9(420)	75(739)	.02	19
3	3(30)	0(151)	119(993)	0(98)	0(145)	0(222)	0	22
5 (2 days)	6(73)	42(320)	15(345)	0(240)	6(297)	6(443)	0	25,28
7	180(103)	72(144)	33(161)	3(112)	6(134)	0(210)	<u>e/</u>	33
8	6(27)	6(59)	5(66)	0(39)	3(88)	0(104)	0	35
9	834(501)	448(205)	1220(719)	48(128)	184(306)	296(676)	.04	37
10	153(47)	0(80)	36(100)	0(16)	0(38)	6(56)	0	39
12 (2 days)	12(148)	30(373)	93(412)	3(163)	2(461)	27(582)	0.53	1,37
13	6(89)	6(198)	0(270)	0(200)	0(420)	0(598)	0	11
15	0(9)	0(30)	0(23)	0(25)	0(58)	0(74)	0	13

^a Numbers outside parenthesis represent cercospora spores. Numbers in parenthesis represent other large fungus spores.

^b One-day exposures except for traps collected on August 5 and 12.

^c Center of heavily diseased sugarbeet field.

^d One hundred feet east of the sugarbeet field.

^e Localized shower at farm. No record of rain at nearest weather station 12 miles away.

Table 3B. Number of cercospora spores and other large fungus spores trapped in and near a sugarbeet field at Rosemount, Minnesota.

Trap collection date	Station no. 1 ^c			Station no. 2 ^d			Rainfall inches	Wind speed estimated range M/H
	2 ft	4 ft	7 ft	2 ft	4 ft	7 ft		
Sept 12	20(43)	50(781)	0(1085)	5(640)	5(902)	0(1917)	.43	15-35
13	0(17)	5(75)	0(96)	0(58)	0(52)	0(63)	0	8-15
16 (3 days)	5(438)	0(866)	0(1600)	0(2100)	0(3039)	0(3507)	0	10-36
17	0(62)	0(334)	0(444)	0(231)	0(565)	0(580)	.37	5-15
18	0(57)	4(231)	0(851)	0(632)	6(706)	0(976)	.08	5-18
20	23(11)	0(35)	0(54)	0(45)	0(51)	0(63)	0	3-8
23 (3 days)	56(1061)	0(1351)	15(1225)	19(1102)	1(1821)	0(834)	0	3-20
24	0(276)	0(942)	0(1440)	0(1202)	0(1941)	0(2175)	.30	5-18
25	2(22)	2(117)	0(225)	2(159)	3(153)	0(225)	.20	0-3
26	7(93)	1(491)	0(621)	2(489)	95(741)	0(897)	0	3-7
27	12(72)	0(457)	0(757)	0(612)	0(726)	--	0	7-15
30 (3 days)	3(180)	3(855)	0(1200)	0(1014)	1(1452)	0(1650)	.09	5-25

^a Numbers outside parenthesis represent cercospora spores. Numbers in parenthesis represent other large fungus spores.

^b One-day exposures except for traps collected on September 16, 23, and 30.

^c Center of diseased sugarbeet field.

^d One hundred feet east of the sugarbeet field.

The possible effect of wind was studied further in the laboratory. Diseased leaves bearing many cercospora spores were placed under a dissecting microscope and exposed to the air blast of an electric fan held one foot away. Greased slides were held six inches away on the leeward side of the mounted leaves. Randomly selected cercospora spots on 15 leaves were observed through the microscope during the 5-minute exposure to the air blast. No removal of spores from the spots could be detected and no spores appeared on the greased slides, indicating that wind alone cannot remove cercospora spores from the leaf spots.

The possible role of water in cercospora dissemination was explored. First, diseased sugarbeet leaves wet with dew early in the morning were gently shaken over glass slides to collect samples of the dew droplets which were allowed to dry. Microscopic examination of the areas on the slides where dew drops had dried showed that 79 out of 97 areas contained cercospora spores. The number of spores per microscopic field (100X magnification) ranged from 2 to 500 with the majority of areas having 50 or more spores per field. Second, large droplets of water (2-3 mm in diameter) were permitted to roll across the surface of sporulating spots being observed under a dissecting microscope and the spores were readily removed. The same happened with water droplets falling directly on the spots. It is apparent from these trials that cercospora spores can be effectively removed from diseased leaves by water.

If spores are dispersed by water, appreciable numbers should be found regularly in Station number 1 at 2 feet, since this trap is almost touching the leaves. However, the hydrophobic properties of the silicone-greased strip were found to prevent all but about 1% of the water-carried spores to stick on, whereas dry spores were readily captured. Therefore, a different spore trap will have to be used for studying water-disseminated spores.

Although only occasional spores were trapped 100 feet away from the beet field, small numbers of wind-borne spores may be important for establishing scattered infection loci in remote, isolated sugar beet fields.

Most of the evidence found here does not strongly support the concept of wind dissemination. More direct evidence of the importance of water dispersal is needed before its role can be conclusively demonstrated. However, the impression from earlier publications that this fungus is primarily wind disseminated will probably have to be modified. At present, it appears that *C. beticola* spores are detached from leaf spots only by water and are subsequently disseminated by either wind or water, the latter agent playing a more important role than was previously realized.

P A R T XIII

PHYSIOLOGICAL INVESTIGATIONS

Studies on
Seed Germination and Quality

F. W. Snyder

Research conducted in cooperation with Michigan Agricultural
Experiment Station.

PHYSIOLOGICAL INVESTIGATIONS-1963^{1/}

F. W. Snyder

Germination Studies^{2/}

ABSTRACT: Ripeness of the seed at harvest strikingly affects the percentage germination of sugarbeet seeds. The seeds in fruits that fully ripen on the plant (fruits that are straw-colored) germinate more rapidly and completely than those in fruits harvested before full maturity (fruits that are dark or greenish-colored). In commercially harvested seedlots, the percentage germination appears to be inversely related to the percentage of immature or dark-colored fruits.

Three commercial monogerm seedlots (SL 122ms x 5460-0, Lot 2433; F 61-562H0 x SP 5460-0, Lot 2401; F61-562H0 x US 401-4n, Lot 2361) harvested in 1962 had a sizable percentage of fruits that were dark or greenish-colored. The germination percentages, corrected for undeveloped or partially developed seeds, were approximately 80, 62, and 63, respectively. Thus, from 20 to 38 percent of the seeds that appeared to be sufficiently developed to germinate failed to do so. In contrast, two seedlots, (SL 126 x 128) ms x 5822-0 and (SL 129 x 133) ms x 5822-0, harvested in 1963 contained very few fruits that were dark or greenish-colored. These corrected germination percentages were approximately 89. Only 11 percent of the developed seeds failed to germinate.

Hand-harvested samples of monogerm seed were collected in Oregon in 1963 from 25 plants of (SL 126 x 128) ms x 5822-0 and of (SL 129 x 133) ms x 5822-0. One set of samples was collected 18 days and the other set 3 days before the field was cut for commercial harvest. Some of the samples collected early were very green, while other samples contained some fruits that were straw-colored and some that ranged to a very greenish color. The late-harvest samples contained only straw-colored fruits. The germination data are summarized in Table 1. The low germination percentages for the early harvest might be expected. However, when 2 of the larger fruited samples with the highest germination were examined for developed seeds, only 3 to 5 percent of the fruits contained no seed or a poorly developed seed. Thus, more than half of the plump seeds from the early harvest failed to germinate. The data (Table 1) might include considerable plant to plant variation, since the seeds for the early harvest were collected from different plants than those for the later harvest.

Fruits of plant #10 of variety (SL 126 x 128) ms x 5822-0 were separated into ripe (straw-colored) and green (green-colored) categories and also by sizes. Each class had approximately 100 fruits which contained a developed seed. Ripeness again appeared to affect the percentage germination

^{1/} Research conducted in cooperation with Michigan Agricultural Experiment Station.

^{2/} The samples of seed were supplied by the West Coast Beet Seed Company and the Farmers and Manufacturers Beet Sugar Association.

(Table 2). Since size of fruit was confounded with ripeness, another study of the effect of ripeness was designed using fruits of plant #25 of variety (SL 129 x 133) ms x 5822-0. The data (Table 3) indicate a significant effect of ripeness, particularly if the data are combined into three categories of ripeness. Seeds in the straw-colored fruits germinated 92.5 percent; those in the intermediate (Intermediate and Ripest categories), 66.3; and those in the green (Green and Greenest), 35.2 percent.

The effect of ripeness and fruit size on the percentage germination of a commercially harvested monogerm variety, F 61-562H0 x SP 5460-0, Lot 2401, appears to be as marked as for the single plants (Table 4). The germination of the ripest and greenest fractions when averaged closely approximated the germination percentage for a bulked sample of the variety.

Although ripeness of seed is a critical factor, germination percentages of fully mature, hand-harvested seeds from individual plants indicate that other factors also may be involved (Table 5).

At the 1960 ASSBT meeting, Hogaboam and Snyder reported that seeds in the smaller fruits generally germinated more rapidly than those in larger fruits. This was true for fruits harvested when straw-colored, but recent tests indicate that if maturity is a factor, the tendency for the smaller fruits to be less ripe may reverse this trend. Thus, immaturity may be indicated when seeds in the smaller fruits germinate relatively slowly and less completely than those in the larger fruits.

Table 1. Effect of ripeness on percentage germination of seed of 25 plants of 2 monogerm varieties.

Variety	No. days before comm'l. harvest	Percentage germination in 10 days*	
		Average	Range among plants
(SL 126 x 128) ms x 5822-0	18	10.1	0 - 37
	3	87.8	45 - 98
(SL 129 x 133) ms x 5822-0	18	14.5	0 - 39
	3	83.5	61 - 98

*Data not corrected for undeveloped or partially developed seeds in fruits.

Table 2. Ripeness as related to speed and percentage germination of seeds of plant #10, variety (SL 126 x 128) ms x 5822-0.

Fruit size	Ripeness of fruits	Accumulated percentage germination by days				
		3	5	7	10	14
Variable	Straw-colored	25.0	79.3	91.3	91.3	94.6
On 10/64" screen	Green	3.0	46.5	57.4	68.3	77.2
On 8/64" screen	Green	0.0	20.5	28.9	50.6	63.9

Table 3. Ripeness and size as related to percentage germination of seeds of plant #25, variety (SL 129 x 133) ms x 5822-0.

Fruit size	Ripeness	No. of fruits	Accum. % germination by days*			
			4	7	10	14
On 13/64" screen	Straw-colored	30	30	80	97	97
	Intermediate	20	60	70	75	75
	Greenest	10	60	60	80	90
On 11/64" screen	Straw-colored	50	54	88	90	90
	Intermediate	50	39	64	66	66
	Green	50	10	24	26	34
	Greenest	50	8	18	24	31
On 10/64" screen	Ripest	20	40	50	50	50
	Greenest	20	15	25	30	35
On 9/64" screen	Ripest	10	17	33	50	67
	Greenest	10	0	0	10	10
On 8/64" screen	Greenest	10	0	0	20	40

*Data corrected for undeveloped or partially developed seeds in fruits.

Table 4. Effect of ripeness and size of fruit on percentage germination of monogerm variety F 61-562H0 x SP 5460-0, Lot 2401.

Fruit size	Ripeness	% good seeds	Accumulated % germination by days*			
			4	7	10	12
On 9/64" screen	Ripest	99	68	79	83	83
	Greenest	95	17	34	41	44
On 8/64" screen	Ripest	97	45	62	72	76
	Greenest	87	22	34	43	43
On 7/64" screen	Unsorted	76	39	57	62	63

*Data corrected for undeveloped or partially developed seeds in fruits.

Table 5. Variation in percentage germination of seeds from 25 different plants of a variety when hand-harvested at full maturity.

Variety	Percentage germination in 10 days*	
	Average	Range among plants
(SL 126 x 128) ms x 5822-0	91.7	49 - 100
(SL 129 x 133) ms x 5822-0	91.1	70 - 99

*Data corrected for undeveloped or partially developed seeds in fruits.

P A R T XIV

DEVELOPMENT OF BASIC BREEDING MATERIAL AND
EXPERIMENTAL HYBRIDS FOR THE GREAT LAKES REGION

- - - -

INHERITANCE OF MONOGERMNESS

Foundation Project 26

G. E. Coe

DEVELOPMENT OF BREEDING MATERIAL
RESISTANT TO LEAF SPOT AND BLACK ROOT

G. E. Coe

Research under Foundation Project 26 at the Plant Industry Station, Beltsville, Maryland, is directed mainly toward varietal improvement in resistance to *Cercospora* leaf spot and *Aphanomyces* black root. This program contributed to the synthesis of many varieties, hybrids, and other items evaluated in field tests reported in Part IV, 1963 Report.

This part of the report will cover trends in the performances of basic breeding material, nursery tests of some experimental hybrids, and some results of genetic tests with monogerm genes from different sources.

Improvement in Basic Breeding Stocks

The trends of the basic breeding stocks in disease resistance and agronomic characteristics as compared to the performance of US 401 are presented in graph form. Graphs 1 thru 8 provide comparisons of the multigerm and monogerm breeding lines with the performance of US 401. The performance of US 401 is given a numerical value of 100. Ratings higher than 100 indicate that the breeding lines performed better than US 401, and ratings lower than 100 indicate that the breeding lines did not perform as well as US 401. In percentage soluble nonsugar solids, a rating greater than 100 still indicates a better performance than US 401, which means a lower percentage of soluble nonsugar solids. In this case, it must be remembered that better performance means a lesser amount of soluble nonsugar solids.

Compared with US 401, there was an increase in resistance to leaf spot of approximately the same magnitude as reported in 1962 Report, page 326, for both multigerm and monogerm varieties (graphs 1 and 2). Greenhouse tests indicated a slight improvement in monogerm varieties in resistance to black root, but the multigerm lines showed no improvement. Selections made directly from the greenhouse black root tests did show improvement over parental lines, but these are not included in the graph.

The root yield performances of multigerm basic breeding stocks in 1963 were inconclusive (graph 3). There was a decrease at the East Lansing, Michigan, nursery and an increase at the Beltsville nursery. The increase at the Beltsville nursery was due at least partially to improved leaf spot resistance; thus it is probable that there was little or no improvement in the yield of the multigerm lines.

The yield performance of monogerm lines at East Lansing (graph 4), although lower than the yield in the 1961 test, was sufficient to indicate a continuing upward trend.

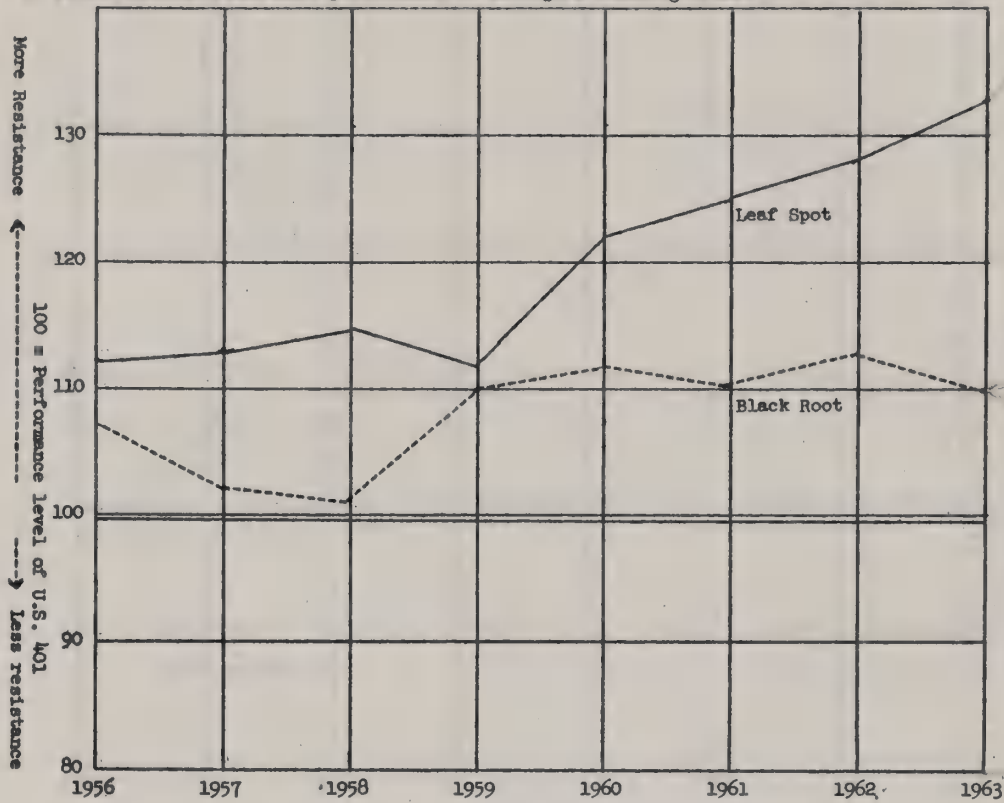
The percent sugar in multigerm breeding lines (graph 5) has shown little variation since 1956. It was higher at Beltsville than US 401, because of improved resistance to leaf spot. It is noteworthy that this good sugar percentage is being maintained despite increased root yields at Beltsville. Paradoxically, these same lines showed no increased sugar percentage at East Lansing despite the fact that yields were lower in comparison to US 401. The sugar percentage of monogerm breeding lines (graph 6) has not changed greatly in recent years, with the exception of 1960 when sugar percentages were high and yields rather low. It should be noted that sugar percentage remained constant in the monogerm lines at a time when root yields increased.

The Beltsville tests indicate that since 1958 there has been considerable improvement (decrease) in the content of soluble nonsugar solids of the multigerm breeding lines (graph 7). Tests of these same lines at East Lansing show a fluctuation of percent soluble nonsugar solids around those of US 401 and indicate no change in this characteristic. However, certain multigerm lines that have been produced from this program have consistently given good purity percentages in field trials. (See the performance of SP 5822-0, SP 6122-0, SP 61151-0, SP 6256-0, and hybrids with these lines as pollinators, in Part IV of this report.) The monogerm lines have been rather high in the percentage of soluble nonsugar solids (low in performance as compared to US 401) since analyzing for this characteristic was started in 1958 (graph 8). The Beltsville data show considerable year-to-year variation of soluble nonsugar solids, and perhaps several more years of data will be necessary before a trend can be defined with confidence. The East Lansing data for 1960 and 1961 indicate only slightly higher content of soluble nonsugar solids (lower numerical values) in the monogerm lines than in US 401. The 1962 data indicate that in the monogerm lines these undesirable soluble nonsugar solids were quite high.

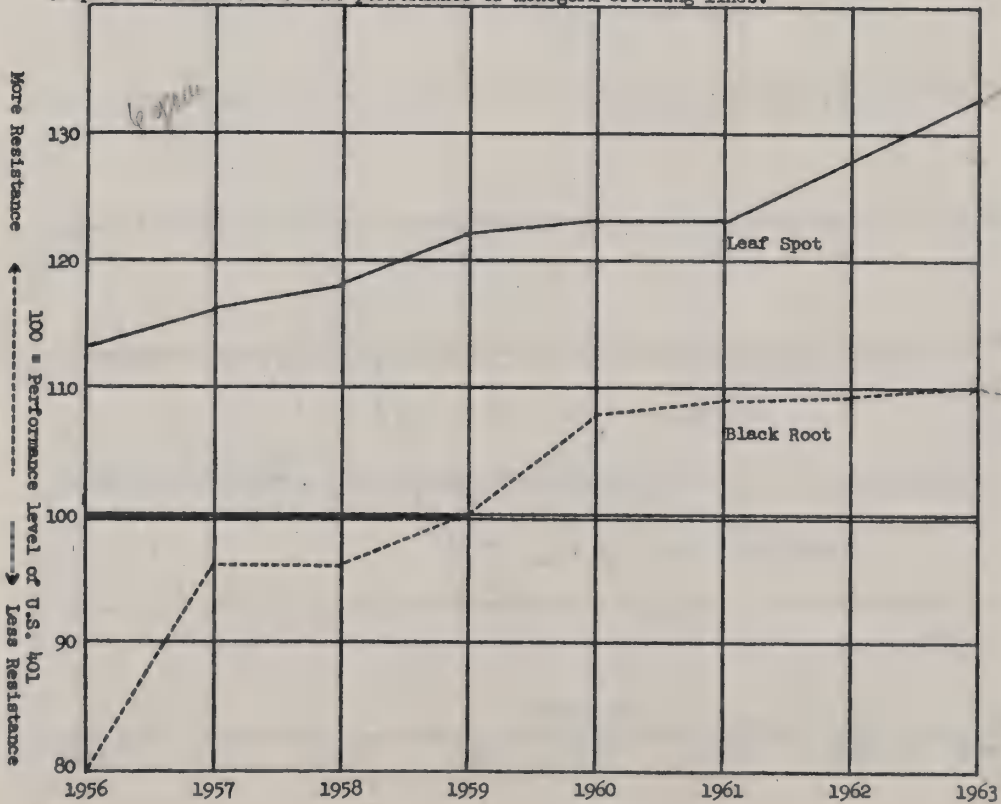
In conclusion, it can be said that most progress has been made in selecting for resistance to leaf spot, whereas progress in improving most other characteristics has been rather slow.

54
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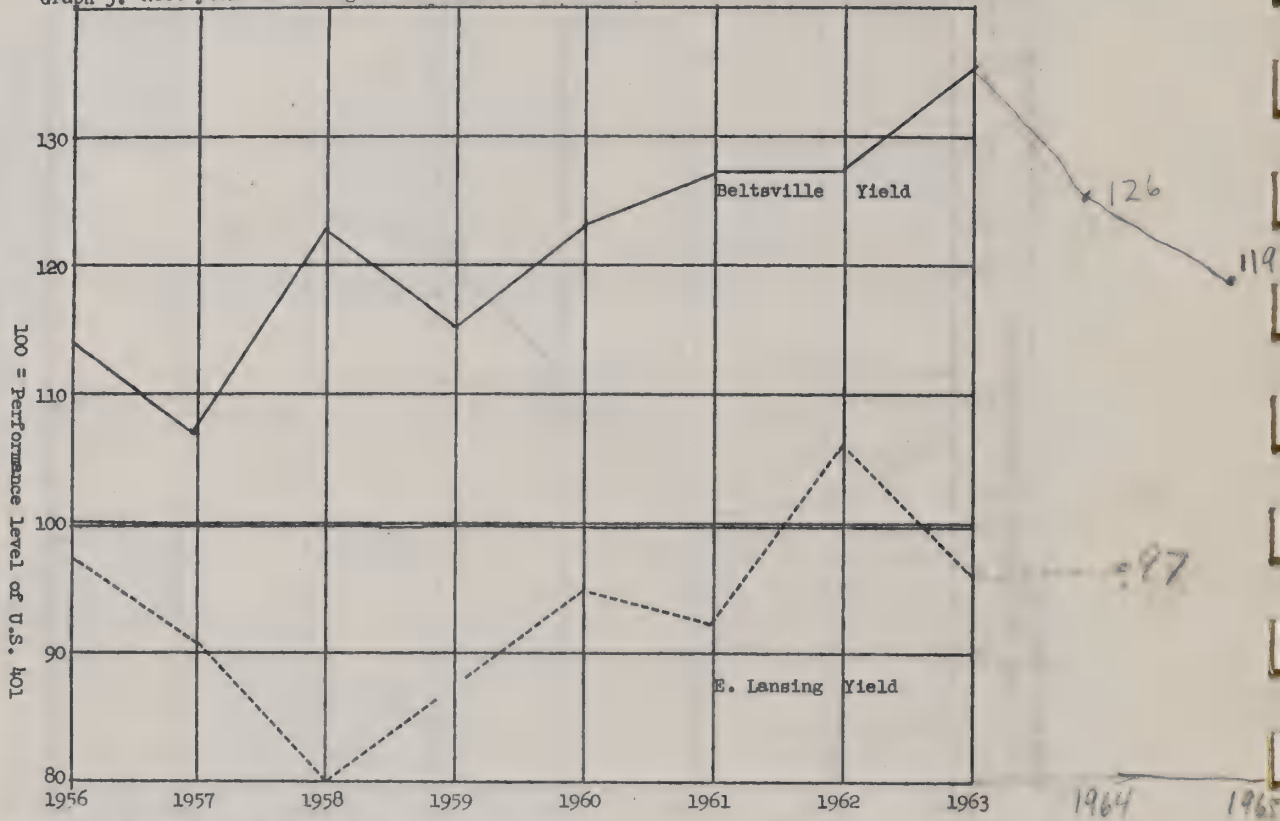
Graph 1. Disease resistance performance of multigerm breeding lines.



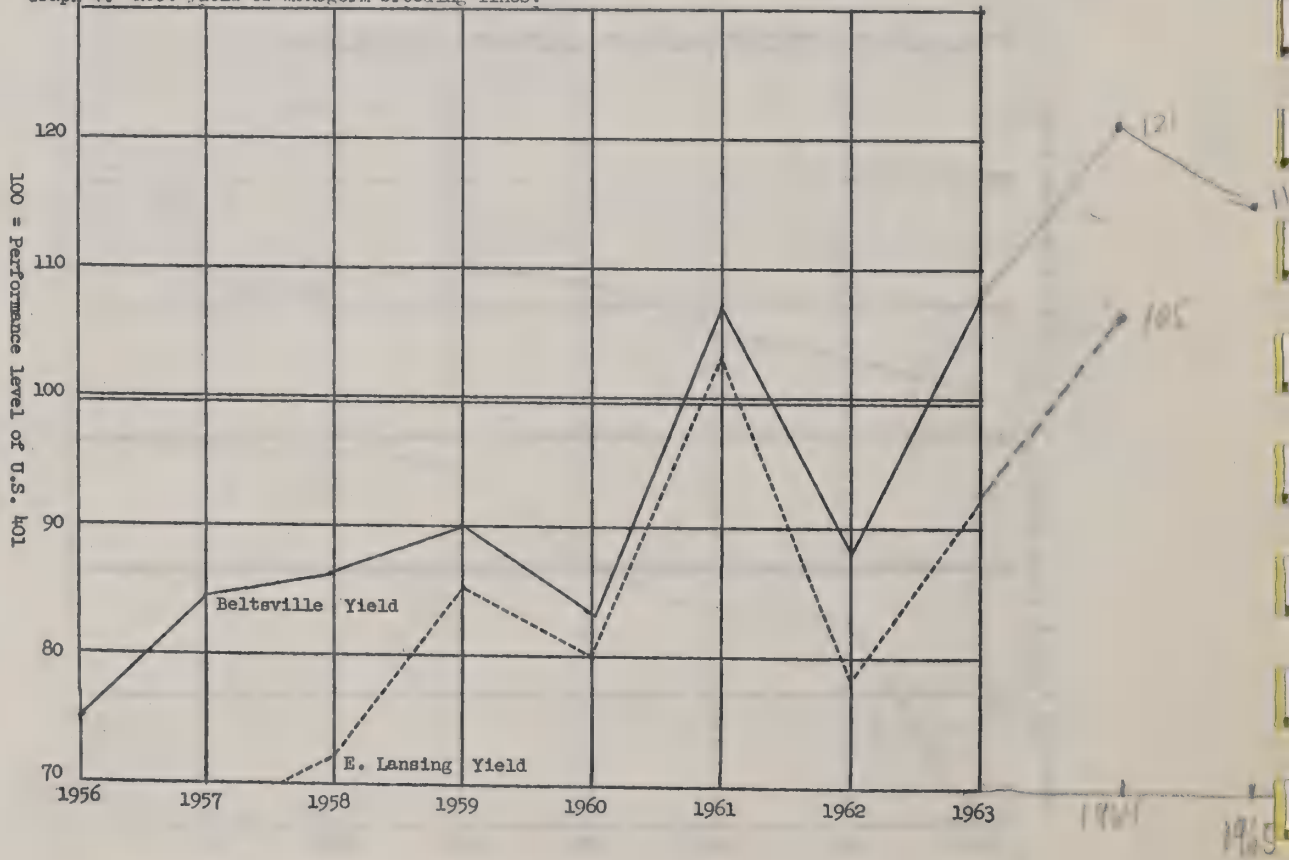
Graph 2. Disease resistance performance of monogerm breeding lines.



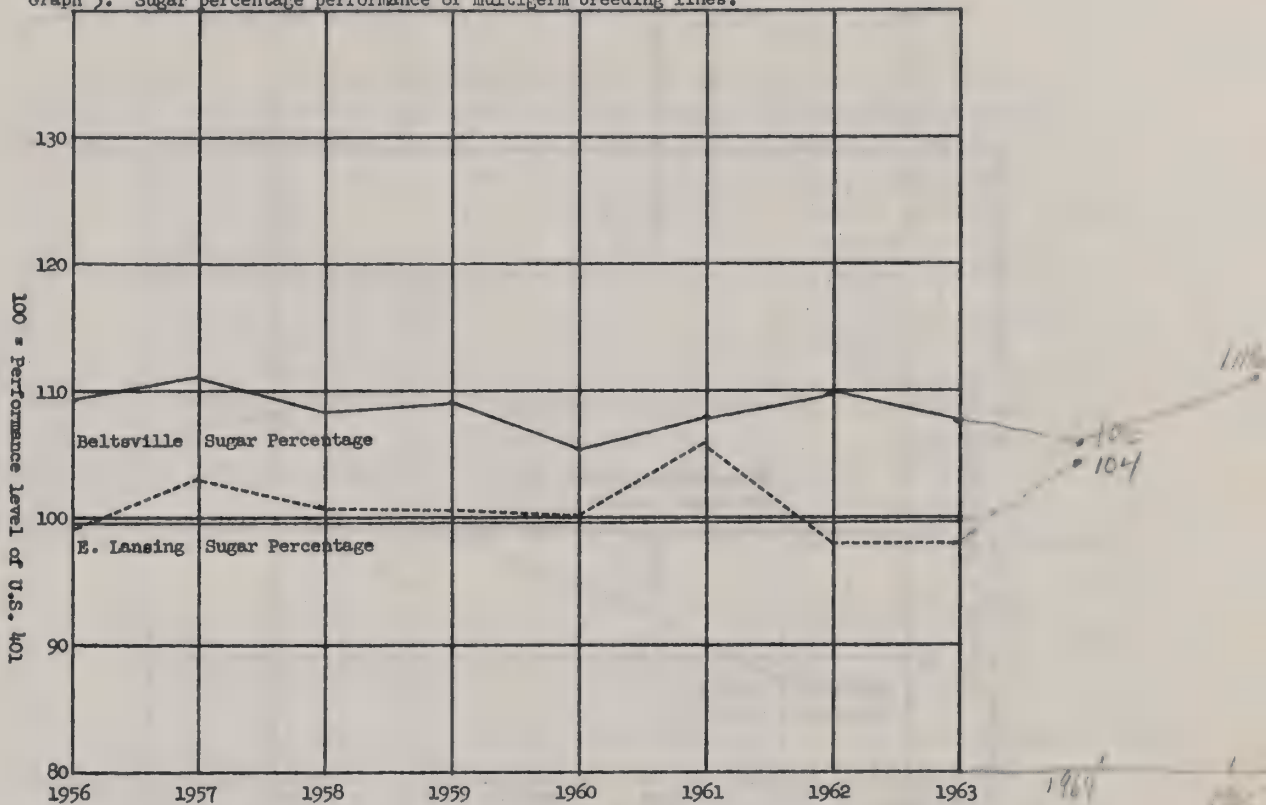
Graph 3. Root yield of multigerm breeding lines.



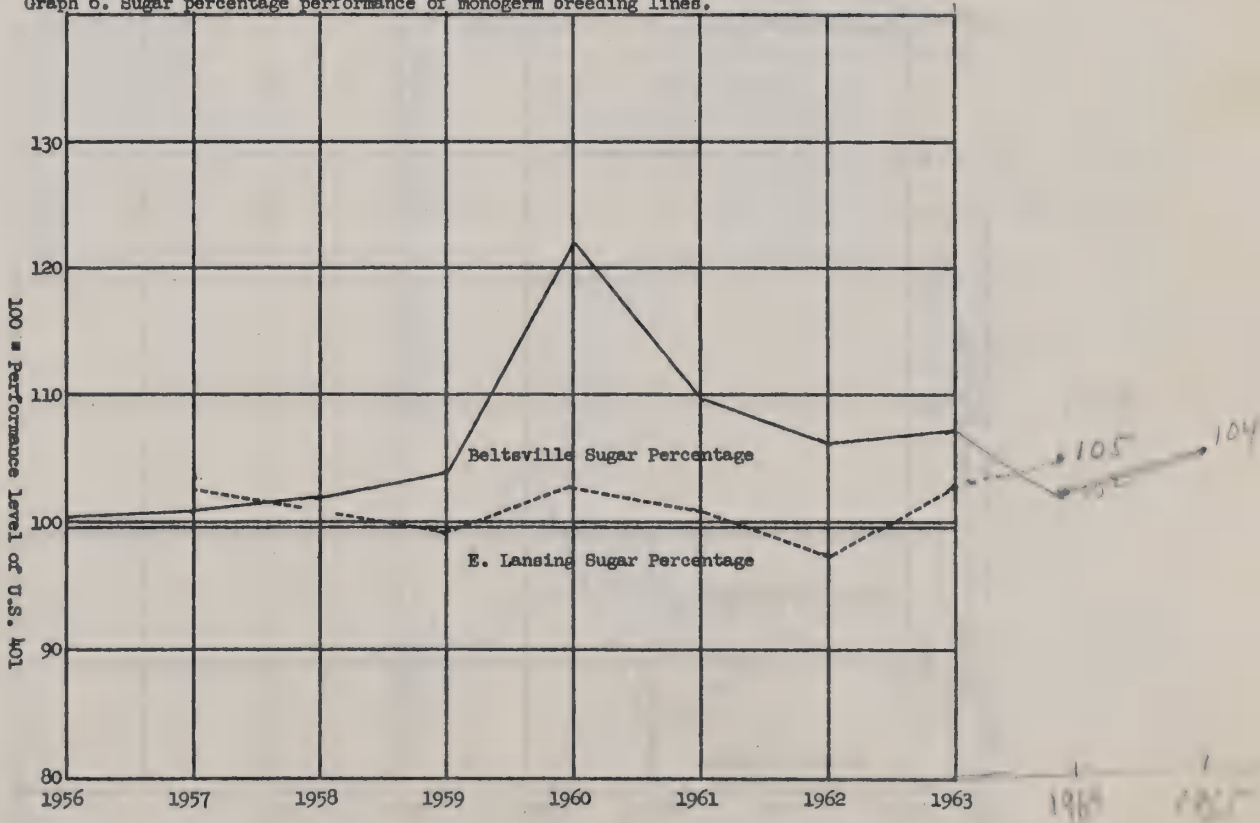
Graph 4. Root yield of monogerm breeding lines.



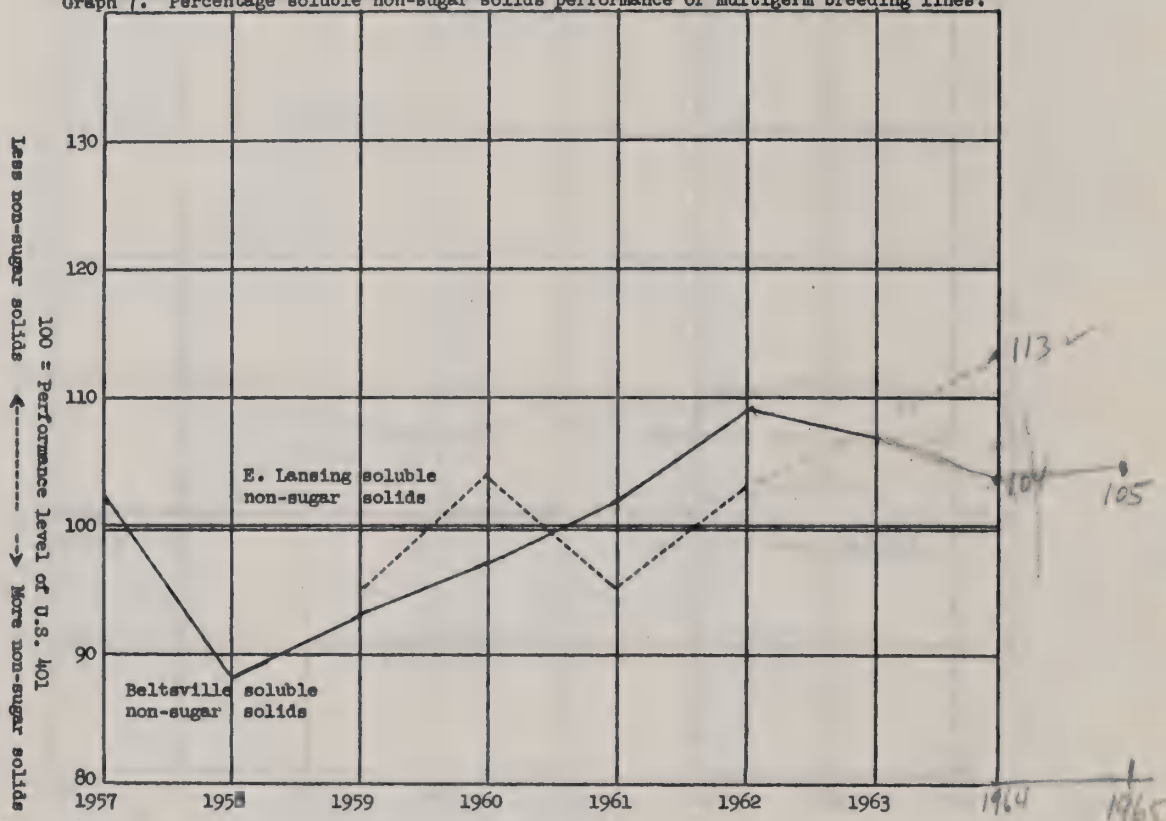
Graph 5. Sugar percentage performance of multigerm breeding lines.



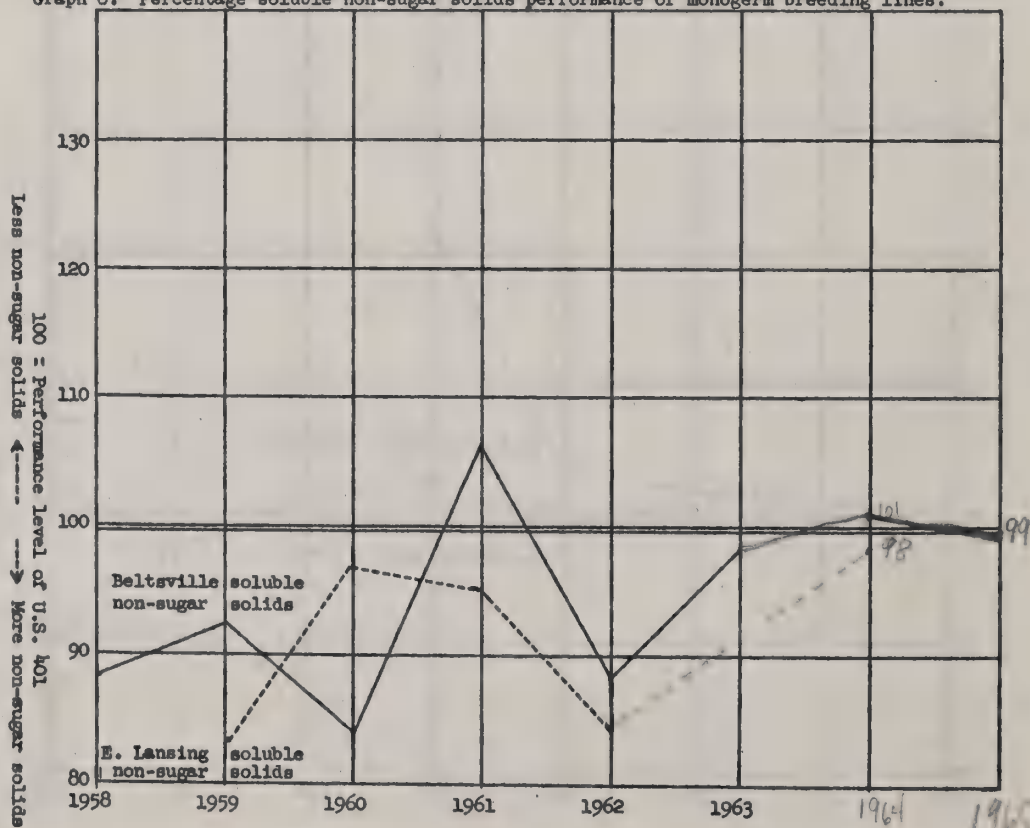
Graph 6. Sugar percentage performance of monogerm breeding lines.



Graph 7. Percentage soluble non-sugar solids performance of multigerm breeding lines.



Graph 8. Percentage soluble non-sugar solids performance of monogerm breeding lines.



Experimental Hybrids Tested at Beltsville

Several experimental hybrids were evaluated in the Beltsville nursery in 1963. Some of these hybrids were also evaluated in preliminary screening tests in the Great Lakes area. Data from the Beltsville test furnish information concerning leaf spot resistance and give some indication of yield potential and quality. In producing the hybrid seed, crosses could not be made in all directions, because of the limited number of plants available of both the female parents and the pollinators. However, the available data are a preliminary indication of the potential performance of the various parent lines. The best female line appears to be SP 6121-01 mm MS and individual plant components of this MS line. (They are hybrid numbers ending in -03, -014, -015, -016, and -017.) Another female line, FC 502 CMS, used in two crosses produced hybrids (hybrid number ending in -010) with the best gross sugar yields and best resistance to leaf spot of any of the hybrids using those particular pollinators. Therefore, this monogerm male-sterile line is worthy of further testing as a female parent.

The three monogerm pollinators used in these crosses produced mediocre hybrids (SP 623000- etc., SP 623359- etc., and SP 623360- etc.), and they should not be considered as potential commercial pollinators. On the otherhand, the hybrids (SP 623356- etc., SP 623357- etc., and SP 623358- etc.) from crosses with the three tetraploid pollinators had reasonably good gross sugar production. However, all the triploid hybrid seed germinated rather poorly and stands were not good. Of the tetraploid pollinators, SP 603107-0 4n MM produced hybrids (SP 623358- etc.) superior in root yield and sugar percentage. It should be noted that these hybrids were not as productive in the Beltsville nursery as the multigerm check varieties SP 61151-0 and SP 6122-0. This is undoubtedly related to more damage to the hybrids by leaf spot. Better leaf spot resistance is needed in the tetraploid pollinator lines. New tetraploids, produced from lines with better resistance to leaf spot, should give triploid hybrids with better performance where leaf spot is serious, than the triploid hybrids presently available.

Leaf Spot Observational Plot

Conducted by: G. E. Coe

Location: Plant Industry Station, South Farm Plot F-11, Beltsville, Md.

Date of Planting: April 25, 1963 *May 4, 1963*

Date of Harvest: October 18, 1963 *Oct 18, 1963*

Experimental Design: One 4-row observational plot

Size of Plots: 4 rows X 20' 24" apart

Harvested Area per plot for Root Yield: 4 rows X 20 feet

Samples for Sucrose Determinations: 2 samples-- all the beets in each of the two middle rows taken as samples.

Stand Counts: Harvested beets counted when weighed

Recent Field History: 1960 - Beets - 400# 10-6-4 + 2% Boron, 2 tons limestone
1961 - Rye - 400# 10-6-4 + 2% Boron, 2 tons limestone
1962 - Rye - 400# 10-6-4 + 2% Boron, 2 tons limestone

Fertilization of Beet Crop: 115 # N, 400# 10-6-4 + 2% Boron, 2 tons limestone

Black Root Exposure: Slight

Leaf Spot Exposure: Moderately severe starting early in July

Other Diseases and Pests: Light infestation of root aphids at harvest.

Soil and Seasonal Conditions: Drought conditions developed by early August and were terminated by irrigation on August 20.

Reliability of test: Good for estimating leaf spot resistance.

Observational Plots

Year: 1963

Location: U.S.D.A. Nursery, Beltsville, Md.

One 4-row plot.

(Results given as average of 4 rows)

Variety and Description	Acre-Yield		Sugar	Roots	Sucrose	Purity	Beets	
	Gross						Leaf	Per 100'
							Spot	Row
	Pounds	Tons						Number
SP 61151-0 MM	7697	26.54	14.50	88.03	2.50	91		
SP 6122-0 MM	7546	26.57	14.20	86.24	3.00	101		
SP 5822-62R MM	5792	21.14	13.70	86.17	3.25	104		
U.S. 401 MM	5053	21.78	11.60	81.81	4.75	103		
SL 126 X SP 5460-0	5195	21.12	12.30	80.75	4.75	104		
SP 623000-02 2 $\frac{1}{2}$ mm Hybrid	4226	17.11	12.35	81.83	3.75	88		
SP 623000-02 $\frac{1}{2}$ " "	4105	15.73	13.05	82.10	4.00	78		
SP 623000-011 " "	4836	19.04	12.70	83.38	4.00	88		
SP 623000-012 " "	4716	20.24	11.65	81.60	3.25	82		
SP 623359-02 " "	4960	19.08	13.00	81.80	4.75	79		
SP 623359-08 " "	5454	23.21	11.75	80.39	4.50	85		
SP 623359-09 " "	4542	19.67	11.55	81.40	5.75	92		
SP 623359-010 " "	6126	22.44	13.65	82.89	3.25	90		
SP 623359-012 " "	5052	20.62	12.25	80.19	4.25	80		
SP 623360-03 " "	4434	18.71	11.85	80.32	3.00	69		
SP 623360-05 " "	4802	21.63	11.10	78.52	3.00	41		
SP 623360-07 " "	4992	20.05	12.45	80.99	3.25	67		
SP 623360-08 " "	4816	17.45	13.80	86.57	4.00	71		
SP 623360-09 " "	4546	17.22	13.20	85.61	5.00	77		
SP 623360-010 " "	6515	21.79	14.95	84.91	2.00	83		
SP 623356-04 3 $\frac{1}{2}$ mm Hybrid	5908	23.08	12.80	82.26	3.50	77		
SP 623356-05 " "	5428	21.54	12.60	81.73	4.00	77		
SP 623356-07 " "	5763	21.83	13.20	82.56	3.75	77		
SP 623356-08 " "	6102	22.03	13.85	85.84	4.25	95		
SP 623356-09 " "	6254	23.08	13.55	82.25	4.00	97		
SP 623356-014 " "	6549	23.90	13.70	85.40	4.00	90		
SP 623356-015 " "	6591	24.32	13.55	82.97	3.75	84		
SP 623356-016 " "	6135	21.99	13.95	82.54	5.00	107		
SP 623356-017 " "	7117	25.06	14.20	85.01	4.00	106		
SP 623357-02 " "	5815	20.62	14.10	84.87	4.00	89		
SP 623357-011 " "	6982	24.50	14.25	83.86	3.50	72		
SP 623357-012 " "	6052	23.01	13.15	83.19	4.00	74		
SP 623357-013 " "	5134	19.30	13.30	83.65	3.00	49		
SP 623358-03 " "	6251	22.01	14.20	84.29	3.25	78		
SP 623358-04 " "	6655	23.19	14.35	85.87	4.50	76		
SP 623358-07 " "	6287	23.46	13.40	76.73	4.00	85		
General Mean	5679	21.50	13.16	83.01	3.85	84		

Inheritance of the Monogerm Characteristic

For several years, tests have been conducted in an attempt to determine the nature of the relationship of the monogerm characteristic derived from three sources. The characteristic was obtained from the American source (SL 101), the Russian monogerm, and the monogerm from a Beta maritima imported from England (PI 211874). Classification of plants as either monogerm or multigerm was difficult, because they may range in fruit type from 100 percent monogerm through plants with increasing numbers of fruits developing from "double" and "triple" flower clusters. The other extreme of fruit type was found in plants whose fruits developed from clusters of four or more flowers--sometimes from as many as 10. For this reason, it was necessary to set up an arbitrary fruit-type classification system. The classification used in the studies at Beltsville is similar to the one used by Owen and Ryser in the 1959 Sugar Beet Research Report but should not be thought of as being identical. The Beltsville classification is as follows:

- 0 - All flowers single, except that as many as three double flowers are allowed on the central floral axis above the uppermost lateral branch.
- 2 - Flowers mostly single; but some doubles permitted on the central axis.
- 4 - At least half the flowers single; many doubles occurring on central axis or also on side branches. An occasional triple flower on the central axis above the uppermost lateral branch permissible.
- 6 - Mostly doubles; less than 50 percent single flowers. May be all double flowers. Some triple flowers permissible.
- 8 - More than 50 percent of flowers triple. Only rarely are single flowers permissible. Clusters of four or more flowers often present.
- 10 - Mostly clusters of four or more flowers. Some triples permissible. No singles or doubles present.

Classes 0, 2, and 4 are considered to be monogerm, because they rarely produce plants in selfed progenies which may be placed in classes 6, 8, and 10. Classes 6, 8 and 10 are considered multigerm, because they may produce a minority of plants in selfed progenies which can be placed in classes 0, 2, or 4.

Sometimes when it was difficult to classify a plant it was given the number between the two classes.

Two plants were found in a B. maritima introduction (PI 211874) from Devon, England, having single pollen-sterile flowers. These were pollinated with pollen from several leaf spot and black root tolerant multigerm

breeding lines. Only a few fruit were set on these two Beta maritima plants. The fruit produced seven seedlings that were brought to flower and allowed to freely interpollinate. All seven plants in this F₁ generation were multigerm and pollen fertile, indicating recessive factors in the original B. maritima plants for monogermness and male sterility. Seed was harvested individually from the F₁ plants and theoretically should have produce F₂ progenies with similar ratios of monogerm to multigerm plants and similar ratios of pollen-fertile to pollen-sterile plants. The data in table 1 indicate that such is not the case. The ratios varied widely among the F₂ progenies, and there was no relation between the multigerm to monogerm ratio and the pollen-fertile to pollen-sterile ratio. It can be concluded that the plants in the original cross were widely divergent genetically and/or that many factors influenced the expression of these characteristics. Plants breeding true for the monogerm character were recovered in later generations. These plants were used in later crosses with the American monogerm.

Each year since 1953, crosses between plants of the American monogerm source and leaf spot and black root resistant multigerm plants were made. The seed was harvested from each monogerm plant individually, but of course, in the F₁ progenies it was not possible to distinguish plants having a common pollinator from those having other pollinators. Selected F₁ plants, all of which were multigerm, were allowed to freely interpollinate. Seed was harvested from each F₁ plant individually. This seed was planted to recover monogerm plants in the F₂ generation. The ratio of multigerm plants to monogerm plants varied widely from progeny to progeny. This result is similar to the result of the cross which furnished the data for table 1. The percentage of monogerm plants was most commonly between 10 and 15 percent, although some F₁ progenies had as few as 1 percent monogerm plants and a few progenies had as many as 50 percent monogerm plants. Again this indicates many factors influencing the expression of fruiting type and a wide genetic variation of the plants used in the original crosses.

Table 1.--Fruit classification and pollen fertility classification of F₂ progeny of a cross between monogerm male-sterile Beta maritima X multigerm pollen-fertile sugarbeet.

Seed No. of F ₁ plant	Fruit classification			Male-fertility classification		
	Multigerm (number)	Monogerm (number)	M-/mm Ratio	Pollen- fertile (number)	Pollen- sterile (number)	PF/MS Ratio
563043-1	36	23	1.57:1	43	16	2.69:1
563043-2	64	12	5.33:1	54	22	2.45:1
563043-3	38	21	1.81:1	49	10	4.90:1
563043-4	25	2	12.50:1	19	8	2.38:1
563043-5	21	32	.66:1	29	24	1.21:1
563043-6	3	2	1.50:1	3	2	1.50:1
563043-7	67	12	5.58:1	40	39	1.03:1
Totals	254	104	2.44:1	237	121	1.96:1

I. Cross between Russian Monogerm X American Multigerm

When the Russian monogerm plants were received, crosses were made in bags in the greenhouse. A Russian monogerm plant with class 3 fruit type was bagged with an American multigerm having class 8 fruit type and shall be referred to as Cross No. 1. Both plants of this cross appeared to be self sterile. The classification of the fruits of the F_1 plants from the Russian monogerm and subsequent generations are presented in table 2. All the F_1 plants grown from the P_1 Russian monogerm seed were multigerm. Many of the F_1 plants were self sterile and consequently were lost when selfing was attempted. Only four of the selfed F_1 plants produced seed. To guard against complete loss of the line, four paired crosses were made among the F_1 plants. Again it can be seen that the ratios of multigerm plants to monogerm plants in the F_2 progenies varied greatly. The totals of the F_2 progenies give a ratio of 4:1 monogerm plants to 1 monogerm plant. Another point of interest is that F_2 progenies of reciprocal crosses were more similar to each other in fruit type than to progenies of other F_1 crosses. Generally, this was true in all the paired matings in the studies of inheritance of fruit type. In item 12, table 2, two F_3 multigerm plants were obtained from a selfed F_2 monogerm plant. Hence, a multigerm type was recovered from a monogerm plant. This would not be expected if the multigerm factor were completely dominant over the monogerm factor. Another point of interest is the three monogerm plants of class 0 fruit type recovered in the F_2 generation, even though the P_1 monogerm was only of class 3 fruit type.

The fruit classifications of the F_1 progeny and subsequent generations of the seed harvested from the multigerm P_1 plant are presented in table 3. The results of the reciprocal cross and the cross were quite similar. All the F_1 hybrids were multigerm. There was great variation in the ratio of multigerm to monogerm plants among the F_2 progenies. The totals of the F_2 progenies of the reciprocal cross gave a ratio of 7.07 multigerm plants to 1 monogerm plant. In item 6, table 3, an F_2 plant with class 5 fruit produced plants with class 2, 4, and 6 type fruit in the F_3 progeny. Admittedly it was difficult to say definitely whether the F_2 plant was multigerm or monogerm, but the F_3 progeny had 10 plants that could be classified as monogerm and only 6 plants that could be classified as multigerm. This indicates a lack of dominance of the multigerm gene and perhaps a strong effect of modifying factors.

In the F_2 progenies there were also four F_2 plants with class 0 fruit. Thus, a better type monogerm fruit than that of the Russian P_1 parent was recovered in the F_2 generation.

It should be noticed in table 3 that two of the F_1 crosses--items 10 and 11 and items 21 and 22--gave no monogerm plants in the F_2 generation. Unfortunately, this can be accounted for by the possibility of a low percentage of pseudo-self-fertility in the multigerm P_1 plant.

Table 2. Fruit classification of descendants of cross #1---Russian monogerm (class 3 fruit type) sugarbeet X American multigerm (class 8 type fruit) sugarbeet

Item	Generation of Parent(s)	Female Parent			Male Parent			Seed No. of Progeny of Female Parent	Fruit Classification of Progeny					
		Seed Number	Type of Fruit	X or \square	Seed Number	Type of Fruit	monogerm \leftarrow --- --- \rightarrow multigerm							
							0		2	4	6	8	10	
									Number of plants					
1	P ₁	Russian mm	3	X	Amer. MM	8	593086-1	0	0	0	10	5	4	
2	F ₁	593086-1	6	\square	None	-	603785.	0	1	1	5	4	0	
3	F ₁	"	6	\square	"	-	603786.	0	0	1	3	2	1	
4	F ₁	"	10	\square	"	-	603787.	0	1	1	5	2	0	
5	F ₁	"	10	\square	"	-	603788.	0	2	0	1	6	4	
6	F ₁	593086-1	6	X	593086-1	-	603755-1	0	0	3	14	3	0	
7	F ₁	Reciprocal of Item 6					603755-2	0	0	2	10	3	1	
8	F ₁	593086-1	6	X	593086-1	8	603756-1	1	0	1	2	3	2	
9	F ₁	Reciprocal of Item 8					603756-2	1	0	1	8	4	4	
10	F ₁	593086-1	8	X	593086-1	8	603757-1	0	2	4	9	7	1	
11	F ₁	Reciprocal of Item 10					603757-2	0	2	1	8	3	2	
12	F ₂	603757-1	4	\square	None	-	623766.	0	0	0	2	0	0	
13	F ₁	593086-1	8	X	593086-1	8	603758-1	0	0	1	0	0	0	
14	F ₁	Reciprocal of Item 13					603058-2	1	0	3	4	1	1	
Number plants in F ₁ Progeny								0	0	0	10	5	4	
Totals of F ₂ Progenies								3	8	19	69	38	16	
Number plants in F ₃ Progeny								0	0	0	2	0	0	

Table 3. Fruit classification of descendants of the reciprocal of cross #1
 ---American multigerm (class 8 fruit type) X Russian monogerm
 (class 3 fruit type) sugarbeet.

Item	Generation of Parent(s)	Female Parent		X or Ø	Male Parent		Seed No. of Progeny of Female Parent	Fruit Classification of Progeny					
		Seed Number	Type Fruit		Seed Number	Type Fruit		monogerm <---/---> multigerm					
								0	2	4	6	8	10
								Number of Plants					
1	P ₁	Amer. MM	8	X	Russian mm	3	593086-2	0	0	0	8	3	11
2	F ₁	593086-2	6	Ø	None	-	603789.	1	0	1	0	0	3
3	F ₁	593086-2	6	Ø	"	-	603790.	1	1	0	1	1	0
4	F ₁	593086-2	6	X	593086-2	6	603769-1	0	0	2	11	5	1
5	F ₁	Reciprocal		of	Item 4		603769-2	1	0	1	10	4	1
6	F ₂	603769-1	5	Ø	None	-	623769.	0	1	9	6	0	0
7	F ₁	593086-2	6	X	593086-2	8	603770-1	0	0	2	11	7	2
8	F ₁	Reciprocal		of	Item 7		603770-2	0	1	4	6	5	0
9	F ₂	603770-2	6	Ø	None	-	623770.	0	0	0	1	0	0
10	F ₁	593086-2	6	X	593086-2	10	603771-1	0	0	0	3	3	10
11	F ₁	Reciprocal		of	Item 10		603771-2	0	0	0	2	2	7
12	F ₁	593086-2	8	X	593086-2	8	603775-1	0	0	2	6	8	2
13	F ₁	Reciprocal		of	Item 12		603775-2	0	0	2	8	9	1
14	F ₁	593086-2	10	X	593086-2	10	603774-1	0	0	0	6	6	4
15	F ₁	Reciprocal		of	Item 14		603774-2	0	0	4	4	10	1
16	F ₂	603774-1	6	Ø	None	-	623771.	0	0	0	2	2	0
17	F ₁	593086-2	10	X	593086-2	10	603772-1	0	0	2	6	4	3
18	F ₁	Reciprocal		of	Item 17		603772-2	0	0	0	5	7	4
19	F ₁	593086-2	10	X	593086-2	10	603773-1	1	0	3	1	7	2
20	F ₁	Reciprocal		of	Item 19		603773-2	0	0	0	1	2	2
21	F ₁	593086-2	10	X	593086-2	10	603776-1	0	0	0	1	5	12
22	F ₁	Reciprocal		of	Item 21		603776-2	0	0	0	1	2	0
Number of plants in F ₁ Progeny								0	0	0	8	3	11
Totals of F ₂ Progenies								4	2	23	83	87	55
Totals of F ₃ Progenies								0	1	9	9	2	0

II, Crosses between Russian Monogerm and American Monogerm

Cross No. 2 - Self-sterile Russian monogerm, class 5 fruit type X self-fertile American mm class 1 fruit type.--The fruit classification of F_1 , F_2 , and F_3 progenies from this cross are presented in table 4. The P_1 Russian monogerm plant contained only about 50 percent monogerm fruits, the remainder being doubles except for a few triples along the central axis. Since it was not definitely a monogerm plant, the fruit was classed as No. 5 rather than No. 4 or No. 6. The F_1 progeny had plants varying in fruit type from 0 to 6, indicating the heterogeneity of factors influencing fruit type in the P_1 plants. Since multigerm F_1 plants were in the minority, it can be concluded that the dominance of the multigerm factor(s) from the Russian P_1 plant had been overcome by the monogerm factor or other factors modifying fruit type. It should be noted in item 5, table 4, that multigerm plants were recovered in the F_2 generation from a self-pollinated F_1 plant having class 0 fruit. In this F_1 plant the multigerm factors were completely hidden by factors for monogermness. This is also true for one or both of the two F_1 plants crossed in items 8 and 11, table 4. It is also true for the self-pollinated F_2 plant in item 21, table 4. On the otherhand, the monogerm F_2 plants in items 6, 7, and 17, table 4, bred true for the monogerm fruit type, apparently having few or no factors for multigermness.

Seed from the reciprocal cross, i.e., from the American monogerm plant SP 57791-01, was planted and the plants used in test crosses with F_1 hybrids from another American monogerm X Russian monogerm hybridization. Since those data are not pertinent to this study of closebred descendants, they will not be presented here.

A trend was noticed in all the inheritance studies of fruit type; namely, when plants are selected at the extreme ends of the range in fruit type and increased by selfing (or crossing with another plant in the progeny with a similar fruit type), their offspring usually tend to have a range of fruit types similar to that of the previous generation, only rarely having a plant with a fruit type beyond the range of the selected parent. This was especially true at the upper end of the fruit classification scale. For instance, if a plant with class 8 fruit was selected from a progeny with a range of fruit types distributed about a median of 2 or 4, the selfed progeny always had a range of fruit type distributed about a median of 2 or 4 and only rarely was there a plant with a class 10 fruit type.

Cross No. 3 - Self-sterile Russian monogerm plant with class 5 fruit X self-fertile American monogerm plant, SP 5831-016, with class 1 fruit.--The fruit classification of F_1 and F_2 progenies are presented in table 5. The F_1 progeny had fruit types ranging from 2 to 6, again indicating the heterogeneity of at least one of the P_1 monogerm parents. Only 2 of the 19 plants in the F_1 progeny could be classed as multigerm, indicating the lack of dominance of the multigerm factor over monogermness. The multigerm to monogerm ratios in the F_2 progenies varied greatly. The total of all the F_2 progenies gave a ratio of 1 multigerm plant to 1.19 monogerm plants. This is further evidence against simple single-gene control of fruit type.

Table 4. Fruit classification of descendants of cross #2---self-sterile Russian monogerm (class 5 fruit type) X self-fertile American monogerm (class 1 fruit type).

Item	Generation of Parent(s)	Female Parent		X or Φ	Male Parent		Seed No. of Progeny of Female Parent	Fruit Classification of Progeny						
		Seed Number	Fruit Type		Seed Number	Fruit Type		monogerm \leftarrow \rightarrow multigerm						
								0	2	4	6	8	10	
									Number of Plants					
1	P ₁	Russian mm	5	X	57791-01	1	593084-1	1	5	10	8	0	0	
2	F ₁	593084-1	4	Φ	None	-	603778.	2	1	6	8	4	0	
3	F ₁	593084-1	4	Φ	"	-	603779.	3	0	1	8	0	0	
4	F ₁	593084-1	4	Φ	"	-	603780.	1	0	2	1	2	0	
5	F ₁	593084-1	0	Φ	"	-	603777.	1	0	1	2	1	0	
6	F ₁	593084-1	2	X	593084-1	2	603735-1	16	8	2	0	0	0	
7	F ₁	Reciprocal		of	Item 6		603735-2	11	6	3	0	0	0	
8	F ₁	593084-1	2	X	593084-1	2	603736-1	5	2	5	9	0	0	
9	F ₂	603736-1	6	Φ	None	-	623720.	0	1	0	9	1	0	
10	F ₂	603736-1	6	Φ	"	-	623721.	0	1	4	19	2	0	
11	F ₁	Reciprocal		of	Item 8		603736-2	4	0	2	8	1	0	
12	F ₁	593084-1	4	X	593084-1	4	603737-1	5	1	4	5	2	0	
13	F ₂	603737-1	6	Φ	None	-	623722.	8	3	3	15	0	0	
14	F ₂	603737-1	5	Φ	"	-	623700.	1	0	0	4	0	0	
15	F ₁	Reciprocal		of	Item 12		603737-2	6	3	8	6	3	0	
16	F ₂	603737-2	6	Φ	None	-	623723.	5	1	8	14	0	0	
17	F ₂	603737-2	0	Φ	"	-	623725.	46	0	0	0	0	0	
18	F ₁	593084-1	4	X	593084-1	4	603738-1	1	0	1	0	1	0	
19	F ₁	Reciprocal		of	Item 18		603738-2	1	0	5	7	3	0	
20	F ₁	593084-1	4	X	593084-1	4	603739-1	2	0	1	2	0	0	
21	F ₂	603739-1	0	Φ	None	-	623728.	8	4	3	1	0	0	
22	F ₁	Reciprocal		of	Item 20		603739-2	4	1	1	3	1	0	
23	F ₂	603739-2	6	Φ	None	-	623729.	0	0	1	19	3	0	
24	F ₂	603739-2	4	Φ	"	-	623730.	1	1	4	8	0	0	
25	F ₁	593084-1	6	X	593084-1	6	603740-1	6	0	3	11	4	0	
26	F ₂	603740-1	6	Φ	None	-	623701.	0	0	0	0	1	0	
27	F ₂	603740-1	6	Φ	"	-	623702.	0	0	1	0	1	0	
28	F ₁	Reciprocal		of	Item 25		603740-2	5	0	2	13	0	0	
29	P ₁	Reciprocal		of	Item 1		593084-2	9	4	0	4	0	0	
Totals of F ₁ Progenies								10	9	10	12	0	0	
Totals of F ₂ Progenies								73	22	47	83	22	0	
Totals of F ₃ Progenies								69	11	24	89	8	0	

Table 5. Fruit classification of descendants of cross #3--Russian monogerm (class 5 fruit type) X self-fertile American monogerm (class 1 fruit type).

Item	Generation of Parent(s)	Female Parent		X or Ξ	Male Parent		Seed No. of Progeny of Female Parent	Fruit Classification of Progeny					
		Seed Number	Fruit Type		Seed Number	Fruit Type		monogerm $\leftarrow - - 1 - - \rightarrow$ multigerm					
								0	2	4	6	8	10
Number of Plants													
1	P ₁	Russian mm	5	X	5831-016	1	593085-1	0	1	16	2	0	0
2	F ₁	593085-1	4	X	593085-1	2	603745-1	6	3	6	4	0	0
3	F ₁	Reciprocal		of	Item 2		603745-2	3	3	7	3	0	0
4	F ₁	593085-1	4	X	593085-1	4	603746-1	7	1	2	13	0	0
5	F ₁	593085-1	4	X	593085-1	4	603747-1	2	1	2	16	0	0
6	F ₁	593085-1	6	X	593085-1	6	603748-1	3	1	1	4	0	0
7	F ₁	Reciprocal		of	Item 6		603748-2	1	1	0	2	0	0

III. Crosses between Beta maritima monogerm source X American monogerm

Cross No. 4 - Beta maritima monogerm with class 0 fruit type X American monogerm with class 2 fruit type, Seed harvested from the B. maritima monogerm source produced only 6 plants - 5 with class 0 fruit and 1 with class 2 fruit (table 6). Two of the F_1 plants with class 0 fruit type crossed together produced 9 plants in the F_2 progeny, all of which had class 0 fruit (items 2 and 3, table 6).

The seed harvested from the American monogerm plant produced 11 F_1 plants having fruit type ranging from 0 to 4 (item 4, table 6). One of the F_1 plants with class 4 fruit was self-pollinated. Its F_2 progeny had a range of fruit type similar to the previous generation (item 5, table 6). Two other plants having class 4 fruit in the F_1 progeny were crossed. The F_2 progeny of one of the plants had 14 multigerm plants and only 1 monogerm plant (item 13, table 6), and the F_2 progeny of the other plant had 7 multigerm and 7 monogerm plants in the F_1 progeny (item 14, table 6). Other F_1 plants in the progeny 593081-2 could have resulted from selfing of the self-fertile American monogerm P_1 plant. The conclusion may be made that the P_1 plants of this cross carried hidden factors for multigermness that were able to express themselves in the F_2 generation.

Cross No. 5 - Monogerm male-sterile plant from B. maritima source with class 2 fruit X self-fertile American monogerm with class 1 fruit.-- Seed harvested from the P_1 male-sterile plant produced 9 F_1 plants, all of which had class 6 fruit (table 7). In this case it would seem that two different complementary loci were involved. If this were true, the progenies would have given a dihybrid ratio; however, they did not. Too many monogerm plants were produced. The F_3 progeny of self-pollinated F_2 plants gave a ratio of 8.33 multigerm plants to 1 monogerm plant; but again this does not approach a simple inheritance ratio, which indicates many factors influencing fruit type.

The seed from the other P_1 plant in this cross produced descendants with class 0 to 2 fruit type. Since the P_1 parent was self fertile, it is unlikely that any of the F_1 plants from this parent were actually F_1 hybrids. From their appearance, it is probable that they were inbreds.

Table 6. Fruit classification of descendants of cross #4---self-sterile monogerm derived from Beta maritima source (class 0 fruit type) X self-fertile American monogerm (class 2 fruit type)

Item	Generation of Parent(s)	Female Parent		X	Male Parent		Seed No. of Progeny of Female Parent	Fruit Classification of Progeny					
		Seed Number	Fruit Type	or	Seed Number	Fruit Type		monogerm <- 1 -> multigerm					
								0	2	4	6	8	10
								Number of Plants					
1	P ₁	<u>B. mar.</u>	0	X	Amer. mm	2	593081-1	5	1	0	0	0	0
2	F ₁	593081-1	0	X	593081-1	0	603710-1	4	0	0	0	0	0
3	F ₁	Reciprocal		of	Item 2		603710-2	5	0	0	0	0	0
4	P ₁	Reciprocal		of	Item 1		593081-2	6	2	3	0	0	0
5	F ₁	593081-2	4	Ø	None	-	603795.	7	6	4	0	0	0
6	F ₁	593081-2	0	X	593081-2	0	603711-1	6	0	1	0	0	0
7	F ₂	603711-1	4	Ø	None	-	623703.	1	9	1	0	0	0
8	F ₁	Reciprocal		of	Item 6		603711-2	2	0	0	0	0	0
9	F ₁	593081-2	2	X	593081-2	2	603712-1	8	5	0	0	0	0
10	F ₁	Reciprocal		of	Item 9		603712-2	4	0	0	0	0	0
11	F ₁	593081-2	2	X	593081-2	2	603713-1	10	3	0	0	0	0
12	F ₁	Reciprocal		of	Item 11		603713-2	0	0	0	0	0	0
13	F ₁	593081-2	4	X	593081-2	4	603714-1	1	0	0	11	3	0
14	F ₁	Reciprocal		of	Item 13		603714-2	2	0	5	6	1	0
Total of F ₁ Progenies								11	3	3	0	0	0
Totals of F ₂ Progenies								49	14	10	17	4	0
Total of F ₃ Progeny								1	9	1	0	0	0

Table 7. Fruit classification of descendants of cross #5---male-sterile monogerm derived from Beta maritima source (class 2 fruit type) X self-fertile American monogerm (class 1 fruit type)

Item	Generation of Parent(s)	Female Parent		X	Male Parent		Seed No. of Progeny of Female Parent	Fruit Classification of Progeny					
		Seed Number	Type Fruit	or	Seed Number	Type Fruit		monogerm <-- --> multigerm					
								0	2	4	6	8	10
								Number of Plants					
1	P ₁	<u>B. mar.</u>	2	X	Amer. mm	1	593082-1	0	0	0	9	0	0
2	F ₁	593082-1	6	♂	None	-	603791.	3	1	4	9	1	0
3	F ₂	603791.	4	♂	None	-	623708.	3	0	0	1	0	0
4	F ₂	603791.	6	♂	"	-	623709.	0	0	3	25	0	0
5	F ₂	603791.	6	♂	"	-	623710.	0	0	2	13	0	0
6	F ₁	593082-1	6	X	593082-1	6	603715-1	0	0	0	2	0	0
7	F ₁	Reciprocal		of	Item 6		603715-2	4	1	1	7	1	0
		Number Plants in F ₁ Progeny						0	0	0	9	0	0
		Totals of F ₂ Progenies						7	2	5	18	2	0
		Totals of F ₃ Progenies						3	0	5	39	0	0

Cross No. 6 - Monogerm male-sterile plant from *Beta maritima* source having class 4 fruit X self-fertile American monogerm having class 1 fruit.

Seed harvested from the male-sterile plant produced an F_1 progeny having a range of fruit type from 2 to 6 (table 8). Contrast this to the previous cross where all the F_1 plants had class 6 fruit type. In crossing two monogerm plants having the monogerm factors derived from different sources, one cannot predict to what degree monogermness will occur in the F_1 generation. In items 7 and 8, table 8, multigerm plants were also recovered from a cross between two monogerm F_1 plants having class 2 fruit. One or both of the F_1 plants, even though they were monogerm, must have been carrying factors for multigermness. Attempts were made in the F_1 and F_2 generations to recover plants breeding true for the multigerm characteristic by self-pollinating plants with class 6 fruit. These attempts were unsuccessful, which means that they were all carrying factors for monogermness. It should not be concluded that true-breeding multigerm plants cannot be extracted from this line of breeding, because only a limited number of self-fertile plants were bagged.

Conclusions

- 1) No two monogerm factors from the three sources are identical alleles.
- 2) It is likely that the monogerm factor from the *Beta maritima* source is at a different locus from the locus of the American monogerm factor.
- 3) Many factors exert an influence on fruit type.

Table 8. Fruit classification of descendants of cross #6---male-sterile monogerm derived from *Beta maritima* source (class 4 fruit type) X self-fertile American monogerm(class 1 fruit type).

		Female Parent	X		Male Parent	Seed No.	Fruit Classification of Progeny.						
			or			of	monogerm ←-- --> Multigerm						
		Seed Number	♂	Seed Number		of Female Parent	0	2	4	6	8	10	
							Number of Plants						
1	P ₁	<u>B. mar.</u>	4	X	Amer. mm	1 593083-1	0	3	15	12	0	0	
2	F ₁	593083-1	6	♂	None	- 603792.	4	0	3	11	0	0	
3	F ₂	603792.	6	♂	"	- 623711.	1	1	0	1	0	0	
4	F ₂	603792.	6	♂	"	- 623712.	1	1	1	9	0	0	
5	F ₁	593083-1	6	♂	None	- 603793.	5	2	1	10	1	0	
6	F ₂	603793.	6	♂	"	- 623713.	0	0	0	1	0	0	
7	F ₁	593083-1	2	X	593083-1	2 603716-1	2	0	0	2	0	0	
8	F ₁	Reciprocal		of	Item 7	603716-2	2	1	2	1	0	0	
9	F ₁	593083-1	4	X	593083-1	4 603718-1	4	1	7	17	0	0	
10	F ₂	603718-1	6	♂	None	- 623705.	7	3	6	7	0	0	
11	F ₁	Reciprocal		of	Item 9	603718-2	5	1	2	12	0	0	
12	F ₁	593083-1	6	X	593083-1	6 603720-1	1	0	1	12	1	0	
13	F ₁	Reciprocal		of	Item 12	603720-2	2	0	3	7	2	0	
14	F ₁	593083-1	6	X	593083-1	6 603721-1	2	0	3	2	1	0	
15	F ₁	Reciprocal		of	Item 14	603721-2	0	0	0	0	0	0	
Number of plants in F ₁ progeny							0	3	15	12	0	0	
Totals of F ₂ Progenies							27	5	22	74	5	0	
Totals of F ₃ Progenies							9	5	7	18	0	0	

